APPENDIX A

Exploration Park Phase I Record of Environmental Consideration

Avoid Verbal Orders

TO: Space Florida/Pete Eggert **DATE: 08/20/2019**

FROM: SI-E3/Environmental Management Branch

SUBJECT: KSC Record of Environmental Consideration (REC) **REC #: 10766**

1. PROJECT INFORMATION

Project Title: Firefly Aerospace Manufacturing Facility

Project Lead: Pete Eggert, Space Florida, 321-730-5301 x123 **Project No.:** SPFL_Firefly_8-15-2019

Project Description:

Construction of approximately 182K sq ft Manufacturing Facility in Exploration Park Phase 1. Please see aerial photos, location, and conceptual layout/site plan attached to checklist for details.

Future expansion development is also shown, but Space Florida or Tenant would request update of REC when required, only included for reference at this time.

EPB Reviewer: LPH **Facility No.:** Firefly Manufacturing Facility

2. NEPA DETERMINATIONS

- ☐ **a. Categorical Exclusions per 14 CFR Part 1216.304(d)**
- ☐ **b. Environmental Assessment (EA) Required**
- ☐ **c. Environmental Impact Statement (EIS) Required**
- ☑ **d. Existing FONSI or ROD**
- ☐ **e. Centerwide EIS**
- ☐ **f. AF Project on KSC/813**
- ☐ **g. NASA Project on CCAFS/813**

3. ENVIRONMENTAL REQUIREMENTS

a. Non-Permit Requirements	☑ **YES**	☐ **NO**
b. Permit Requirements	☑ **YES**	☐ **NO**

2.a.1. ENVIRONMENTAL ASSESSMENT (EA): The proposed action under the Firefly Aerospace Manufacturing Facility construction project was covered under the original Finding of No Significant Impact (FONSI) for the EA developed for Exploration Park - Phase 1 in December 2008. For additional information, please contact Don Dankert of the NASA Environmental Management Branch (SI-E3, 861-1196).

3.a.1. MANHOLE DEWATERING POTENTIAL RELEASE LOCATION (PRL): This project may include work within the boundary of PRL 204, Manhole Dewatering Operations. There is an institutional control being implemented on the soil within a 25 ft radius of manholes on KSC. The soil adjacent to telecommunications and electrical manholes is contaminated with barium, copper, lead and polynuclear aromatic hydrocarbons. The maximum concentrations found are barium at 410 mg/kg, copper at 440 mg/kg, lead at 4,900 mg/kg and B(a)P Equivalent at 35.4 mg/kg. If handling the soil (excavation or any other activity in which the soil is disturbed and handled by workers) within 25 ft of a manhole, contact your company's Safety and Health Office for recommendations on appropriate personal protective equipment (PPE). All soil being disturbed within 25 ft of the manhole being dewatered must remain within that 25 ft radius. If this is not possible the soil must be properly disposed. All efforts should be made to cause the dewatered effluent to be discharged in a sheet flow along grade and not be allowed to scour the soil at the discharge point. Erosion protection will be provided as needed and applicable to prevent the disturbance/erosion of soil due to construction activities and dewatering near manholes. For more information, or if soil must be disturbed, please contact Mike Deliz (SI-E2, 867-6971) to discuss control/disposal options.

3.a.2. HAZARDOUS/NON-HAZARDOUS WASTE: All hazardous and non-hazardous wastes must be properly containerized, stored, labeled, manifested, shipped, and disposed of by Space Florida or their tenant Firefly Aerospace in full regulatory compliance. Hazardous wastes generated by this activity must be manifested, shipped, and disposed of under the Space Florida or Firefly Environmental Protection Agency (EPA) identification number for the premises. Firefly shall maintain copies of waste management records and manifests onsite and make them available for review by NASA upon request. Firefly is responsible for any spills, releases, or other environmental contamination that occurs as a result of the proposed activities. A KSC Pollution Incident Report (PIR) Form (KSC Form 21-555) must be completed and submitted to the NASA Environmental Assurance Branch (EAB) within three (3) calendar days of the incident. All releases must be reported immediately by calling 321-867-7911, and then to the NASA EAB by calling 321-867-9005. A Pollution Incident Report (PIR) Form (KSC Form 21-555) must be completed and submitted to the NASA EAB within three (3) calendar days of the incident at KSC-DL-NASA-Env-Spill@mail.nasa.gov.

3.a.3. HAZARDOUS AND CONTROLLED WASTE (PAINT): This project will involve the application of paint coatings. All practical precautions must be taken to eliminate the possibility of a release of material or waste into the environment (primers/paints) from the paint surface preparation and painting operation. Paint chips, rust, debris, blast media, wastewater, etc. generated during preparation of surfaces will be contained and disposed of according to waste management guidelines given above in item 3.a.2.

3.a.4. PAINT DISTURBANCE/REMOVAL: Any future project involving disturbance/removal of paint coatings at this facility has the potential to encounter the 8 RCRA hazardous metals (Ag, As, Ba, Cd, Cr, Hg, Pb, and Se) and PCBs. Materials with coatings which contain heavy metals or PCBs must be managed and disposed in accordance with OSHA standards and hazardous waste regulations. Disposal of painted materials: Painted construction and demolition waste items will be accepted at the KSC Class III Landfill without PCB or TCLP analysis but must be managed according to PCB bulk product waste storage regulations in 40 CFR Part 761 until disposal in the landfill. This includes covering the materials and storing them on an impermeable surface for protection against precipitation and prevention of soil contamination. Guidelines for disposal of items at the KSC Class III Landfill are outlined in Kennedy NASA Procedural Requirements (KNPR 8500.1, Chapter 14). Contact Zach Hall (SI-E2, 867-5178) for the current version of these requirements.

3.a.5. STORAGE TANKS: The NASA Environmental Assurance Branch (SI-E2) considers Firefly Aerospace to be the responsible party to ensure regulatory compliance associated with the proposed installation of the petroleum storage tank system or any petroleum storage tank systems in accordance with the requirements of Florida Administrative Codes 62-761 and 62-762. Depending on the size of the petroleum storage tank it may be required to be registered with the State of Florida. The Florida Department of Environmental Protection (FDEP) has contracted the responsibility to ensure registered storage tank compliance in Brevard County to Brevard County Natural Resource Management Department (BCNRMD).

3.a.6. SPILL PREVENTION, CONTROL, AND COUNTERMEASURES (SPCC) PLAN: Owners or operators of a facility that produces, stores, or consumes oil or petroleum products in amounts of 1,320 gallons or greater, and could potentially discharge oil in quantities that may be harmful, are required by the U. S. Environmental Protection Agency to prepare a spill prevention, control, and countermeasures (SPCC) plan. An SPCC plan documents the procedures for the prevention, response, control, and reporting of spills of oil to navigable waters or adjoining shoreline. This plan serves as a guide for personnel and organizations responsible for ensuring that all measures are taken to prevent and contain spills and leaks of oil in accordance with Chapter 40, Code of Federal Regulations (CFR) Part 112. Fuel transfers from the storage tank to mobile refuelers would also require spill prevention procedures and countermeasures, such as spill kits, to be available during fuel transfers. In most cases, a professional engineer is required to prepare and/or amend an SPCC plan. Firefly Aerospace is responsible for the development of their SPCC Plan.

3.a.7. THREATENED AND ENDANGERED/PROTECTED SPECIES: Operations and development at the Firefly Aerospace Manufacturing Facilty site have the potential to impact protected or threatened and endangered wildlife species including the Eastern indigo snake and the gopher tortoise. Measures must be taken to minimize impacts to the wildlife and their habitat. If indications of activity by any protected species are present in the project area, possible impacts must be evaluated, and in the case of the gopher tortoise, the burrows must be identified and avoided if possible. If identified burrows are within the area of construction, relocation of animal in question will be required.

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Relocation of gopher tortoises requires a Florida Fish and Wildlife Conservation Commission permit. Additional information on gopher tortoise permits can be found at http://myfwc.com/license/wildlife/gopher-tortoise-permits/.A biological survey will be required to identify potential impacts to habitat within the two weeks immediately preceding start of site work. After the survey has been performed and if gopher tortoise burrows are observed please contact Becky Bolt (IMSS-200, 867-7330). If any indigo snakes are observed, halt all work until the snake has left the area and please inform Becky of the sighting. Do not harm or harass the snakes. Becky is available to conduct a brief wildlife awareness training session for workers either on site or at another location. Please contact Becky at 867-7330 to schedule this wildlife awareness briefing prior to starting land disturbance and equipment mobilization.If vegetation clearing or any disturbance of vegetated areas is necessary, a biological survey will be required to identify potential impacts to habitat and wetlands prior to disturbances.

3.a.8. EXTERIOR LIGHTING: The installation/modification and use of any lighting that is visible from the exterior of a facility or structure must be in compliance with the requirements in the KSC Exterior Lighting Guidelines in Chapter 24 of KNPR 8500.1 Rev. E, and requirements of the US Fish and Wildlife Service Biological Opinion for KSC regarding dark skies and artificial lighting. Safety and hazardous operations can apply for a waiver to allow for use of non-compliant lighting; however, justification must be provided to the NASA Environmental Office. Development of a lighting operations manual (LOM) that meets these criteria is required for all new structures or facilities. Please contact Don Dankert, NASA Environmental Management Branch (SI-E3) at 861-1196 for additional information, and for guidance on development of a LOM or for a copy of the referenced documents.

3.a.9. EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES (BMPs): Precautions must be made to eliminate or reduce to the greatest extent possible any discharge of sediments outside established project boundaries. This can be accomplished by initiating proactive erosion control BMPs. Installation and maintenance of appropriate erosion/sediment control devices (such as wattles, turbidity screens, silt fences, inlet protectors, floating turbidity booms, etc.) must be completed prior to initial land disturbance where the possibility of sediment discharge could impact surrounding stormwater conveyances and other surface waters. The BMPs must be maintained so they remain functional until such time that the newly exposed soils are stabilized with sod or natural vegetation.

3.a.10. CONCRETE WASHOUT: Water used to rinse out concrete trucks and other equipment used for concrete work must not be allowed to discharge to surface waters. Concrete washout water shall be diverted to a settling pond where suspended material will settle out and the water can percolate into the ground. Contact Doug Durham (SI-E2, 867-8429) with any question on this requirement. Remove and dispose of hardened concrete waste consistent with your handling of other construction wastes. After drying/settling, the residue may be disposed of at the Diverted Aggregate Reclamation and Collection Yard (DARCY); and the ground restored. Clean, unstained, unpainted concrete residue is accepted at the DARCY without any sampling and analysis. Contact Zach Hall (SI-E2, 867-5178) with any questions on this requirement.

3.b.1. EXCAVATION PERMIT: A KSC Excavation Permit will be required for any digging proposed by this project. Please contact the Utility Locate/Excavation Permit Request Customer Helpline at 867-2406 or go to website at http://epr.ksc.nasa.gov/Home/ for an underground utility scan and dig permit. NOTE: If a trench or pit is to be left open all day or overnight, the trench/pit must be checked for trapped animals at the beginning and end of each work shift. If an animal is observed trapped, contact Becky Bolt (IMSS-200, 867-7330) or the Duty Office (861-5050, email KSC-ISC-DutyOffice@mail.nasa.gov) to arrange removal/release. Do not handle the animal(s).

3.b.2. PERMITTED STORMWATER ERP: The project area is covered under an existing Environmental Resource Permit (ERP) stormwater system (Exploration Park I, #69567-2) issued to Space Florida by the St. Johns River Water Management District (SJRWMD) and is subject to periodic inspection by the regulator. Information should be provided to

SJRWMD at the design phase for a permit modification determination. Ensure the final configuration of the stormwater system swales/slopes/berms, etc., and final dimensions of the structures meet the engineering requirements of the permitted stormwater facility. For more information, contact SJRWMD. Please coordinate with NASA Environmental Assurance, Doug Durham (SI-E2, 867-8429).

3.b.3. FDEP NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) CONSTRUCTION ACTIVITY PERMIT: This project may require an NPDES Phase II construction permit. If 1 acre or more of land will be disturbed, a NPDES Construction Activity Permit from the Florida Department of Environmental Protection (FDEP) is required under F.A.C. 62-621.300(4), Notice of Intent to Use Generic Permit for Stormwater Discharge from Large (If over 5 Acres) and Small (1 Acre To 5 Acres) Construction Activities. http://www.dep.state.fl.us/water/stormwater/npdes/forms/cgp_noi.pdf. This includes construction activity which will disturb less than one acre of land area that is part of a larger common plan of development that will ultimately disturb equal to or greater than one acre of land. Construction activity does not include routine maintenance that is performed to maintain the original line and grade, hydraulic capacity, or original purpose of the site. A condition of this permit is to provide a Stormwater Pollution Prevention Plan (SWPPP) detailing erosion and turbidity controls for the site. Information on completing the permit application and development of the SWPPP can be obtained by contacting Doug Durham (SI-E2, 867-8429).

3.b.4. DEWATERING: Construction dewatering is exempted from permitting under conditions of Rule 40C-2.051 (7) providing the conditions of exemption are met including: limiting withdrawal methods, limiting withdrawal to less than 300,000 gpd and limiting withdrawal to 30 days. Additional limitations are placed on discharge of produced water to prevent harm to the environment. If conditions of the exemption cannot be met, a construction dewatering general permit is required from SJRWMD using Form 40C-2.900(12). No dewatering may begin until 10 days after submittal of the complete form.If the dewatering activity does not qualify for a general permit by rule under Rule 40C-2.042(9), F.A.C., you must complete and submit a SJRWMD application for an individual Consumptive Use Permit pursuant to Rule 40C-2.041, F.A.C. Approval of the application must be obtained before starting the dewatering activity.If produced water discharge will reach surface waters, an FDEP permit may be required under Rule 62-621.300-2. Contact Doug Durham (SI-E2, 867-8429) with questions related to these requirements.

3.b.5. WATER RESOURCE PERMITTING (Domestic Wastewater): Proposed activities may require a permit from FDEP for the alteration or installation of utilities for transport of domestic wastewater. The organization responsible for the work will ensure that best engineering practices, codes, specifications and standards are followed. Additional flow to the sanitary sewer system will require coordination and approval from the KSC domestic wastewater collection/transmission system operator and the Cape Canaveral Air Force Station (CCAFS) domestic wastewater treatment plant operator. Upgrades to the KSC and CCAFS infrastructure, beyond the Firefly domestic wastewater collection/transmission system, may be required for connection of the Firefly facilities to the KSC sanitary sewer system. These upgrades may include increasing the ability of the KSC domestic wastewater collection/transmission system to transmit, store, and equalize the flow to the CCAFS plant, and possibly contributing funding to increase the treatment capacity.
Firefly shall obtain all required environmental permits, prepare application, and pay application fees. The NASA EAB will sign permit application as landowner or utility system owner if legally required, contact Doug Durham (SI-E2, 867-8429) for assistance. Firefly shall submit courtesy copies of all applications to the NASA EAB within five (5) working days after submission to FDEP. Firefly shall submit courtesy copies of the permit to the NASA EAB within five (5) working days after receipt from FDEP.

3.b.6. INDUSTRIAL WASTEWATER DISCHARGE: Firefly Manufacturing Facility processes may generate industrial wastewater. State of Florida regulations define industrial wastewater as any wastewater that is not classified as domestic wastewater. An Industrial Wastewater Permit may be required for discharge. Firefly shall follow FDEP's Guide

to Permitting Wastewater Facilities or Activities under Chapter 62-620 when preparing the application package. The designs, site plans, specifications, drawings, documents, or forms required by FAC 62-620 must be signed and sealed by a P.E. registered in the state of Florida. The NASA Environmental Assurance Branch (EAB) will sign permit applications as landowner or utility system owner if legally required. Contact Doug Durham (SI-E2, 867-8429) for assistance. Permit applications must be submitted to FDEP at least 180 days before a discharge occurs and at least 90 days prior to commencing construction. Firefly shall submit courtesy copies of all applications to the NASA EAB within five (5) working days after submission to FDEP. Firefly shall submit courtesy copies of the permit to the NASA EAB within five (5) working days after receipt from FDEP. In some instances, industrial wastewater may be approved for discharge to the sanitary sewer system. For discharges to the sanitary sewer system, Firefly shall obtain approval from both Base Operations and Spaceport Services (BOSS) and CCAFS wastewater treatment plant operator. Contact Doug Durham (SI-E2, 867-8429) for additional assistance.

3.b.7. WATER RESOURCE PERMITTING (Potable Water): The proposed project may require a permit for the alteration or installation of utilities for transport of potable or FIREX water. Any work done will be per standards and criteria set forth in the permit requirements, and not jeopardize the health and safety of personnel due to effects of the construction/modification on the KSC potable water system (i.e. disinfection and verification prior to use). Upgrades to the KSC infrastructure, beyond the Firefly Manufacturing Facility potable water system, may be required for connection to the KSC water system.

Firefly Aerospace shall obtain all required environmental permits, prepare application, and pay application fees. The proposed connection to the potable water system must be coordinated with the KSC public water system operator. The NASA EAB will sign permit applications as landowner or utility system owner if legally required. Contact Doug Durham (SI-E2, 867-8429) for assistance. Firefly shall submit courtesy copies of all applications to the NASA EAB within five (5) working days after submission to FDEP. Firefly shall submit courtesy copies of the permit to the NASA EAB within five (5) working days after receipt from FDEP, and ensure that all operations, activities, equipment, and facilities are in full compliance with all permit conditions. Firefly shall maintain copies of all records required to demonstrate compliance with the permit onsite and make them available for review by NASA upon request.

3.b.8. AIR EMISSIONS: NASA KSC holds a facility-wide Federal Clean Air Act Title V Air Operation Permit issued by the Florida Department of Environmental Protection (FDEP) that governs air emissions from dozens of regulated emission sources and hundreds of insignificant emission sources across KSC. Space Florida and tenants are independent from NASA regarding air emissions permitting and compliance. Space Florida and Firefly Aerospace shall contact the NASA EAB prior to:

-The operation, reactivation, or modification of an existing emission source/activity,

-The construction of any new air emission source, and/or

-The initiation of an activity producing air emissions.

Space Florida and Firefly will coordinate with the FDEP to determine applicable air emissions permitting and compliance requirements for future activities, and may be required to obtain separate air permits for these activities.

3.b.9. TRANSFORMERS/GENERATORS: The temporary operation of portable generators during construction is allowed and is not considered a stationary source of air emissions. New generators proposed for permanent use at the facility, and associated air emissions must be reviewed for determination of construction permit and RICE (Reciprocating Internal Combustion Engine) NESHAP (National Emission Standards for Hazardous Air Pollutants) requirements. If a new transformer or generator using a volume of oil equal to or greater than 55 gallons is to be installed, it is subject to SPCC rules.

3.b.10. RADIATION: Use of ionizing or non-ionizing radiation sources on KSC must comply with KNPR 1860.1 and 1860.2. This project may involve the generation of a radiation source which must be evaluated by the Health Physics Group. A Radiation Use Authorization is required before operations begin. Information describing work to be performed and use of x-ray machine must be submitted to the KEMCON/IMSS Health Physics Office. Contact KEMCON/IMSS Health Physics (IMSS-023, 867-2400) with questions.

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No other environmental issues were identified based upon the information provided in the KSC Environmental Checklist. This Record of Environmental Consideration (REC) does not relinquish the project lead from obtaining and complying with any other internal NASA permits or directives necessary to ensure all organizations potentially impacted by this project are notified and concur with the proposed project.

Due to potential changes in regulations, permit requirements and environmental conditions, statements in this REC are valid for 6 months, and subject to review after this period. It is the responsibility of the project lead to submit current project information for a REC update prior to project commencement if REC is older than 6 months; and also to notify the Environmental Management Branch (SI-E3) if the scope of the project changes at any time after the REC is issued.

4. Upon evaluation of the subject project, the above determinations have been made and identified. Contact the Environmental Management Branch (SI-E3) at 861-1196 for re-evaluation should there be any modifications to the scope of work.

James Brooks

08/20/2019 00:00

Date

APPENDIX B

BRRC Noise Report

Blue Ridge Research and Consulting, LLC

Technical Report

Noise Study for Firefly's Cape Canaveral Orbital Launch Site Environmental Assessment

September 24, 2019(Draft)

Prepared for:
Brian Gulliver, P.E
Kimley-Horn
(303) 228-2306
Brian.Gulliver@Kimley-Horn.com

Prepared by:
Michael James, M.S.
Matt Calton, M.S.
Shane Lympany, Ph.D.
Alex Salton, M.S.

Blue Ridge Research and Consulting, LLC
29 N Market St, Suite 700
Asheville, NC 28801
(p) 828-252-2209
(f) 831-603-8321
BlueRidgeResearch.com

Contract Number:
PO #96627001

BRRC Report Number:
BRRC 19-10

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Acronyms and Abbreviations

The following acronyms and abbreviations are used in the report:

BRRC	Blue Ridge Research and Consulting, LLC
CCAFS	Cape Canaveral Air Force Station
CDNL	C-weighted Day-Night Average Sound Level
dB	Decibel
dBA	A-weighted Decibel Level
dBC	C-weighted Decibel Level
DI	Directivity Indices
DNL	Day-Night Average Sound Level
DoD	Department of Defense
DSM-1	Distributed Source Method 1
FAA	Federal Aviation Administration
ft	Foot/Feet
Hz	Hertz
KSC	John F. Kennedy Space Center
lbf	Pound Force
lbs	Pound Mass
$L_{A,max}$	Maximum A-weighted OASPL in Decibels
L_{max}	Maximum Unweighted OASPL in Decibels
L_{pk}	Peak Sound Pressure Level in Decibels
NASA	National Aeronautics and Space Administration
NIHL	Noise-Induced Hearing Loss
NIOSH	National Institute for Occupational Safety and Health
OASPL	Overall Sound Pressure Level in Decibels
OSHA	Occupational Safety and Health Administration
EA	Environmental Assessment
Pa	Pascal
psf	Pounds per Square Foot
RUMBLE	The Launch Vehicle Acoustic Simulation Model

1 Introduction

This report documents the noise study performed as part of Firefly's efforts on the Environmental Assessment (EA) for proposed operations at Cape Canaveral Air Force Station (CCAFS). Firefly plans to conduct static test and vertical launch operations for both Alpha and Beta launch vehicles. The two vehicles are depicted in Figure 1-1. Both the static fire and launch events will occur at Firefly's CCAFS SLC-20 facility. The potential impacts from propulsion noise and sonic boom are evaluated on a single-event and cumulative basis in relation to human annoyance, hearing conservation, and structural damage.

This noise study describes the environmental noise associated with the proposed Firefly operations. Section 2 describes the proposed Firefly operations; Section 3 summarizes the basics of sound and describes the noise metrics and impact criteria discussed throughout this report; Section 4 describes the general methodology of the propulsion noise and sonic boom modeling; and Section 5 presents the propulsion noise and sonic boom modeling results. A summary is provided in Section 6 to document the notable findings of this noise study.

Figure 1-1. Rendering of Firefly's Alpha launch vehicle (top) and Beta launch vehicle (bottom) (credit: Firefly)

2 Firefly Operations

Firefly plans to conduct Alpha operations for up to 10 pre-launch static fire engine tests, 24 acceptance static fire engine tests, and 10 vertical launches per year. Beta operations are planned for up to 18 pre-launch static fire engine tests, 24 acceptance static fire engine tests, and 18 vertical launches per year. The annual operations are presented in Table 2-1 in terms of acoustic time of day. The Alpha static fire and launch events will occur at Firefly's CCAFS SLC-20A (28.513086°N, 80.555917°W), whereas the Beta operations will occur at SLC-20B (28.512221°N, 80.556685°W). Pre-launch and acceptance static engine tests of all four engines will last five seconds and 60 seconds, respectively. Alpha and Beta launch operations will be unique to the vehicle configuration, mission, and environmental conditions. Therefore, a range of launch azimuths between 44° and 110° were simulated using the 85° nominal trajectory provided by Firefly.

Table 2-2 presents Alpha and Beta modeling input parameters used to estimate noise emissions from the proposed Firefly operations. Although the vehicles' sea level (S.L.) thrust is provided in Table 2-2, the model uses a time-varying thrust profile based on the trajectory. The maximum modeled vehicle thrust reaches approximately 165,500 lbf and 617,300 lbf during the first stage launch of the Alpha and Beta, respectively. All operational modeling parameters and trajectories were provided by Firefly personnel.

Table 2-1. Proposed Firefly Alpha and Beta operations

		Annual Operations		
Vehicle	**Event**	Daytime 0700 – 1900	Nighttime 2200-0700	Total
Alpha	Pre-Launch Static Fire	10	0	10
	Acceptance Static Fire	24	0	24
	Launch	10	0	10
Beta	Pre-Launch Static Fire	18	0	18
	Acceptance Static Fire	24	0	24
	Launch	18	0	18

Table 2-2. Firefly Alpha and Beta modeling parameters

Vehicle	**Modeling Parameters**	**Values**
Alpha	Manufacturer	Firefly Aerospace, Inc.
	Name	Alpha
	Length	95 ft
	Diameter	6 ft
	Gross Vehicle Weight	119,019 lbs
	Engines	Firefly Reaver (Qty. 4) 35,613 lbf S.L. Thrust/Engine
	Vehicle's S.L. Thrust	142,452 lbf
Beta	Manufacturer	Firefly Aerospace, Inc.
	Name	Beta
	Length	117 ft
	Diameter	10 ft
	Gross Vehicle Weight	467,419 lbs
	Engines	Name To Be Determined (Qty. 4) 138,906 lbf S.L. Thrust/Engine
	Vehicle's S.L. Thrust	555,624 lbf

3 Acoustics Overview

An overview of sound-related terms, metrics, and effects, which are pertinent to this study, is provided to assist the reader in understanding the terminology used in this noise study.

3.1 Fundamentals of Sound

Any unwanted sound that interferes with normal activities or the natural environment is defined as noise. Three principal physical characteristics are involved in the measurement and human perception of sound: intensity, frequency, and duration [1].

- **Intensity** is a measure of a sound's acoustic energy and is related to sound pressure. The greater the sound pressure, the more energy is carried by the sound and the louder the perception of that sound.
- **Frequency** determines how the pitch of the sound is perceived. Low-frequency sounds are characterized as rumbles or roars, while high-frequency sounds are typified by sirens or screeches.
- **Duration** is the length of time the sound can be detected.

3.1.1 Intensity

The loudest sounds that can be comfortably detected by the human ear have intensities a trillion times higher than those of sounds barely audible. Because of this vast range, using a linear scale to represent the intensity of sound can become cumbersome. As a result, a logarithmic unit known as the decibel (abbreviated dB) is used to represent sound levels. A sound level of 0 dB approximates the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level around 60 dB. Sound levels above 120 dB begin to be felt inside the human ear as discomfort. Sound levels between 130 and 140 dB are experienced as pain [2].

Because of the logarithmic nature of the decibel unit, sound levels cannot be simply added or subtracted and are somewhat cumbersome to handle mathematically. However, some useful rules help when dealing with sound levels. First, if a sound's intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level. For example:

$$50\ \text{dB} + 50\ \text{dB} = 53\ \text{dB}, \text{ and } 70\ \text{dB} + 70\ \text{dB} = 73\ \text{dB}.$$

Second, the total sound level produced by two sounds with different levels is usually only slightly more than the higher of the two. For example:

$$50.0\ \text{dB} + 60.0\ \text{dB} = 60.4\ \text{dB}.$$

On average, a person perceives a change in sound level of about 10 dB as a doubling (or halving) of a sound's loudness. This relation holds true for both loud and quiet sounds. A decrease in sound level of 10 dB represents a 90% decrease in sound intensity but only a 50% decrease in perceived loudness because the human ear does not respond linearly [1]. In the community, "it is unlikely that the average listener would be able to correctly identify at a better than chance level the louder of two otherwise similar events which differed in maximum sound level by < 3 dB" [3].

The intensity of sonic booms is quantified with physical pressure units rather than levels. Intensities of sonic booms are traditionally described by the amplitude of the front shock wave, referred to as the peak

overpressure. The peak overpressure is normally described in units of pounds per square foot (psf), where 1 psf = 47.88 Pascals (Pa). The amplitude is particularly relevant when assessing structural effects as opposed to loudness or cumulative community response. In this study, sonic booms are quantified by either dB or psf, as appropriate for the particular impact being assessed [4].

3.1.2 Frequency

Sound frequency is measured in terms of cycles per second or hertz (Hz). Human hearing ranges in frequency from 20 Hz to 20,000 Hz, although perception of these frequencies is not equivalent across this range. Human hearing is most sensitive to frequencies in the 1,000 to 4,000 Hz range. Most sounds are not simple pure tones, but contain a mix, or spectrum, of many frequencies. Sounds with different spectra are perceived differently by humans even if the sound levels are the same. Weighting curves have been developed to correspond to the sensitivity and perception of different types of sound.

A-weighting and C-weighting are the two most common weightings. These two curves, shown in Figure 3-1, are adequate to quantify most environmental noises. A-weighting puts emphasis on the 1,000 to 4,000 Hz range to match the reduced sensitivity of human hearing for moderate sound levels. For this reason, the A-weighted decibel level (dBA) is commonly used to assess community sound. Very loud or impulsive sounds, such as explosions or sonic booms, can sometimes be felt, and they can cause secondary effects, such as shaking of a structure or rattling of windows. These types of sounds can add to annoyance and are best measured by C-weighted sound levels, denoted dBC. C-weighting is nearly flat throughout the audible frequency range and includes low frequencies that may not be heard but cause shaking or rattling. C-weighting approximates the human ear's sensitivity to higher intensity sounds.

Note, "unweighted" sound levels refer to levels in which no weighting curve has been applied to the spectra. Unweighted levels are appropriate for use in examining the potential for noise impacts on structures.

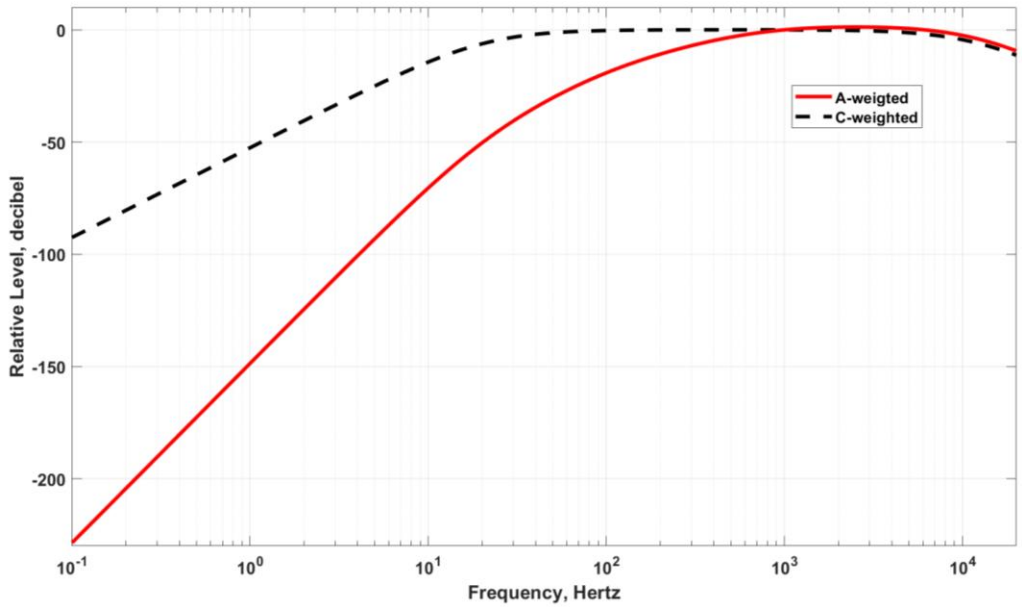

Figure 3-1. Frequency adjustments for A-weighting and C-weighting [5]

3.1.3 Duration

Sound sources can contain a wide range of frequency (pitch) content as well as variations in extent from short durations to continuous, such as back-up alarms and ventilation systems, respectively. Some sound sources (air conditioners, generators, lawn mowers) are continuous with levels that are constant for a given duration; others (vehicles passing by) are the maximum sound during an event, and some (urban day and nighttime) are averages over extended periods [6]. Sonic booms are considered low-frequency impulsive noise events with durations lasting a fraction of a second.

3.1.4 Common Sounds

Common sources of noise and their associated levels are provided for comparison to the noise levels from the proposed action.

A chart of A-weighted sound levels from everyday sounds [7] is shown in Figure 3-2. Per the US Environmental Protection Agency, "Ambient noise in urban areas typically varies from 60 to 70 dB but can be as high as 80 dB in the center of a large city. Quiet suburban neighborhoods experience ambient noise levels around 45-50 dB" [8].

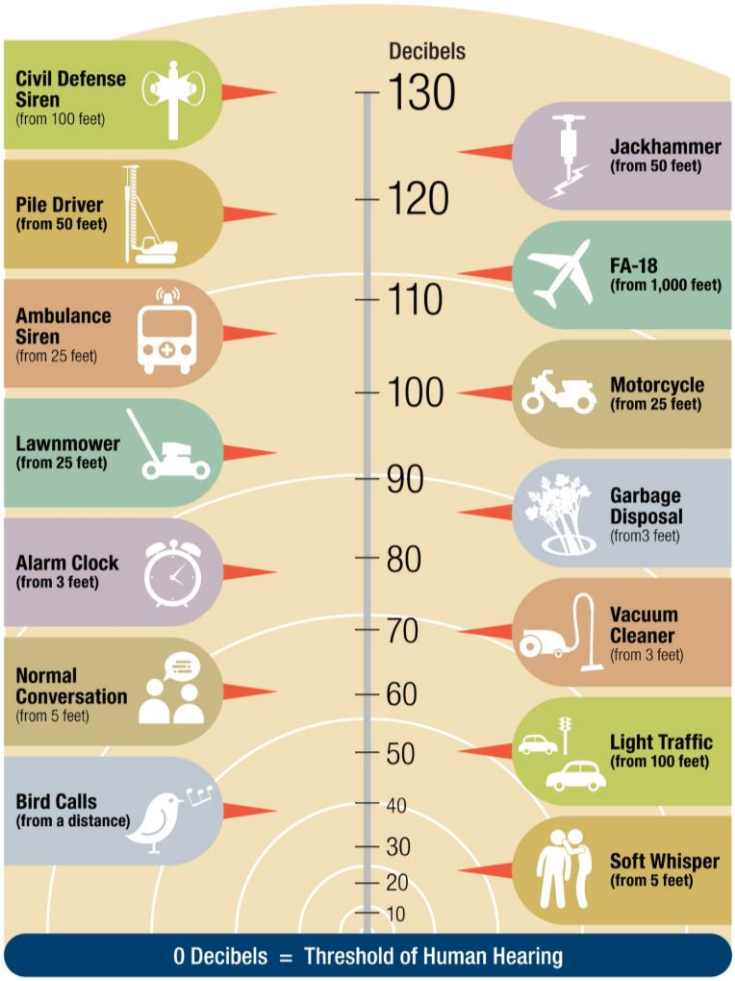

Figure 3-2. Typical A-weighted sound levels of common sounds [9]

A chart of typical impulsive events along with their corresponding peak overpressures in terms of psf and peak dB values are shown in Figure 3-3.

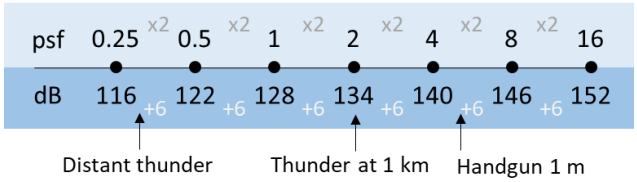

Figure 3-3. Typical impulsive event levels [10]

3.2 Noise Metrics

A variety of acoustical metrics have been developed to describe sound events and to identify any potential impacts to receptors within the environment. These metrics are based on the nature of the event and who or what is affected by the sound. A brief description of the noise metrics used in this noise study are provided below.

Maximum Sound Level (L_{max})

The highest unweighted sound level measured during a single event, in which the sound changes with time, is called the Maximum Sound Level (abbreviated as L_{max}). The highest A-weighted sound level measured during a single event is called the Maximum A-weighted Sound Level (abbreviated as $L_{A,max}$). Although it provides some measure of the event, L_{max} (or $L_{A,max}$) does not fully describe the sound because it does not account for how long the sound is heard.

Peak Sound Level (L_{pk})

For impulsive sounds, the true instantaneous peak sound pressure level, which lasts for only a fraction of a second, is important in determining impacts. The peak pressure of the front shock wave is used to describe sonic booms, and it is usually presented in psf. Peak sound levels are not frequency weighted.

Day-Night Average Sound Level (DNL) and Community Noise Equivalent Level (CNEL)

Day-Night Average Sound Level is a cumulative metric that accounts for all noise events in a 24-hour period. To account for increased sensitivity to noise at night, DNL applies an additional 10 dB adjustment to events during the acoustical nighttime period, defined as 10:00 PM to 7:00 AM. DNL represents the average sound level exposure for annual average daily events. DNL does not represent a level heard at any given time but represent long-term exposure to noise.

3.3 Noise Effects

Noise criteria have been developed to protect the public health and welfare of the surrounding communities. The impacts of launch vehicle noise and sonic booms are evaluated on a cumulative basis in terms of human annoyance. In addition, the launch vehicle noise and sonic boom impacts are evaluated on a single-event basis in relation to hearing conservation and potential structural damage. Although FAA Order 1050.1F does not have guidance on hearing conservation or structural damage criteria, it recognizes the use of supplemental noise analysis to describe the noise impact and assist the public's understanding of the potential noise impact.

3.3.1 Human Annoyance

A significant noise impact would occur if the "action would increase noise by DNL 1.5 dB[A] or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dB[A] noise exposure level, or that will be exposed at or above this level due to the increase, when compared to the No Action Alternative for the same timeframe" [11].

DNL is based on long-term cumulative noise exposure and has been found to correlate well with long-term community annoyance for regularly occurring events including aircraft, rail, and road noise [12, 13]. Noise studies used in the development of the DNL metric did not include rocket noise, which are historically irregularly occurring events. Thus, it is acknowledged that the suitability of DNL for infrequent rocket noise events is uncertain. Additionally, it has been noted that the DNL "threshold does not adequately address the effects of noise on visitors to areas within a national park or national wildlife refuge where other noise is very low and a quiet setting is a generally recognized purpose and attribute" [11]. However, DNL is the most widely accepted metric to estimate the potential changes in long-term community annoyance.

For impulsive noise sources with significant low-frequency content such as sonic booms, C-weighted DNL (CDNL) is preferred over A-weighted DNL [14]. In terms of percent highly annoyed, DNL 65 dBA is equivalent to CDNL 60 dBC [15].

3.3.2 Hearing Conservation

Launch Vehicle Noise

U.S. government agencies have provided guidelines on permissible noise exposure limits. These documented guidelines are in place to protect human hearing from long-term continuous daily exposures to high noise levels and aid in the prevention of noise-induced hearing loss (NIHL). A number of federal agencies have set exposure limits on non-impulsive noise levels, including the Occupational Safety and Health Administration (OSHA) [16], National Institute for Occupational Safety and Health (NIOSH) [17], and the Department of Defense (DoD) Occupational Hearing Conservation Program [18]. The most conservative of these upper noise level limits has been set by OSHA at 115 dBA. At 115 dBA, the allowable exposure duration is 15 minutes for OSHA and 28 seconds for NIOSH and DoD. $L_{A,max}$ contours are used to identify potential locations where hearing protection should be considered for rocket operations.

Sonic Booms

Multiple federal government agencies have provided guidelines on permissible noise exposure limits on impulsive noise such as sonic booms. In terms of upper limits on impulsive or impact noise levels, NIOSH [17] and OSHA [19] have stated that levels should not exceed 140 dB peak sound pressure level, which equates to a sonic boom level of approximately 4 psf.

3.3.3 Structural Damage

Launch Vehicle Noise

Typically, the most sensitive components of a structure to launch vehicle noise are windows, and infrequently, the plastered walls and ceilings. The potential for damage to a structure is unique interaction

among the incident sound, the condition of the structure, and the material of each element and its respective boundary conditions. A report from the National Research Council on the "Guidelines for Preparing Environmental Impact Statements on Noise" [20] states that one may conservatively consider all sound lasting more than one second with levels exceeding 130 dB (unweighted) as potentially damaging to structures.

A NASA technical memo examined the relationship between structural damage claims and overall sound pressure level and concluded "the probability of structural damage [was] proportional to the intensity of the low frequency sound" [21]. This relationship estimated that one damage claim in 100 households exposed is expected at an average continuous sound level of 120 dB (unweighted), and one in 1,000 households at 111 dB (unweighted). The study was based on community responses to 45 ground tests of the first and second stages of the Saturn V rocket system conducted in Southern Mississippi over a period of five years. The sound levels used to develop the criteria were modeled mean sound levels.

It is important to highlight the difference between the static ground tests on which the rate of structural damage claims is based and the dynamic events modeled in this noise study. During ground tests, the engine/motor remains in one position, which results in a longer-duration exposure to continuous levels as opposed to the transient noise occurring from the moving vehicle during a launch event. Regardless of this difference, Guest and Slone's [21] damage claim criteria represents the best available dataset regarding the potential for structural damage resulting from rocket noise. Thus, L_{max} values of 120 dB (unweighted) and 111 dB (unweighted) are used in this report as conservative thresholds for potential risk of structural damage claims.

Sonic Booms

High-level sonic booms are also associated with structural damage. Most damage claims are for brittle objects, such as glass and plaster. Table 3-1 summarizes the threshold of damage that may be expected at various overpressures [22]. Additionally, Table 3-1 describes example impulsive events for each level range. A large degree of variability exists in damage experience, and much of the damage depends on the pre-existing condition of a structure. Breakage data for glass, for example, spans a range of two to three orders of magnitude at a given overpressure. The probability of a window breaking at 1 psf ranges from one in a billion [23] to one in a million [24]. These damage rates are associated with a combination of boom load and glass condition. At 10 psf, the probability of breakage is between one in 100 and one in 1,000. Laboratory tests involving glass [25] have shown that properly installed window glass will not break at overpressures below 10 psf, even when subjected to repeated booms. However, in the real world, glass is not always in pristine condition.

Damage to plaster occurs at similar ranges to glass damage. Plaster has a compounding issue in that it will often crack due to shrinkage while curing or from stresses as a structure settles, even in the absence of outside loads. Sonic boom damage to plaster often occurs when internal stresses are high as a result of these factors. In general, for well-maintained structures, the threshold for damage from sonic booms is 2 psf [22], below which damage is unlikely.

Table 3-1. Possible damage to structures from sonic booms [22]

Nominal level	Damage Type	Item Affected
0.5 – 2 psf piledriver at construction site	Plaster	Fine cracks; extension of existing cracks; more in ceilings; over doorframes; between some plasterboards.
	Glass	Rarely shattered; either partial or extension of existing.
	Roof	Slippage of existing loose tiles/slates; sometimes new cracking of old slates at nail hole.
	Damage to outside walls	Existing cracks in stucco extended.
	Bric-a-brac	Those carefully balanced or on edges can fall; fine glass, such as large goblets, can fall and break.
	Other	Dust falls in chimneys.
2 – 4 psf cap gun/firecracker near ear	Glass, plaster, roofs, ceilings	Failures show that would have been difficult to forecast in terms of their existing localized condition. Nominally in good condition.
4 – 10 psf handgun at shooter's ear	Glass	Regular failures within a population of well-installed glass; industrial as well as domestic greenhouses.
	Plaster	Partial ceiling collapse of good plaster; complete collapse of very new, incompletely cured, or very old plaster.
	Roofs	High probability rate of failure in nominally good state, slurry-wash; some chance of failures in tiles on modern roofs; light roofs (bungalow) or large area can move bodily.
	Walls (out)	Old, free standing, in fairly good condition can collapse.
	Walls (in)	Inside ("party") walls known to move at 10 psf.
> 10 psf fireworks display from viewing stand	Glass	Some good glass will fail regularly to sonic booms from the same direction. Glass with existing faults could shatter and fly. Large window frames move.
	Plaster	Most plaster affected.
	Ceilings	Plasterboards displaced by nail popping.
	Roofs	Most slate/slurry roofs affected, some badly; large roofs having good tile can be affected; some roofs bodily displaced causing gale-end and will-plate cracks; domestic chimneys dislodged if not in good condition.
	Walls	Internal party walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage.
	Bric-a-brac	Some nominally secure items can fall; e.g., large pictures, especially if fixed to party walls.

4 Noise Modeling

An overview of the propulsion noise and sonic boom modeling methodologies used in this noise study are presented in Section 4.1 and 4.2, respectively.

4.1 Propulsion Noise Modeling

Launch vehicle propulsion systems, such as solid rocket motors and liquid-propellant rocket engines, generate high-amplitude broadband noise. Most of the noise is created by the rocket plume interacting with the atmosphere and the combustion noise of the propellants. Although rocket noise radiates in all directions, it is highly directive, meaning that a significant portion of the source's acoustic power is concentrated in specific directions.

The Launch Vehicle Acoustic Simulation Model (RUMBLE), developed by Blue Ridge Research and Consulting, LLC (BRRC), is the noise model used to predict the noise associated with the proposed operations. The core components of the model are visualized in Figure 4-1 and are described in the following subsections.

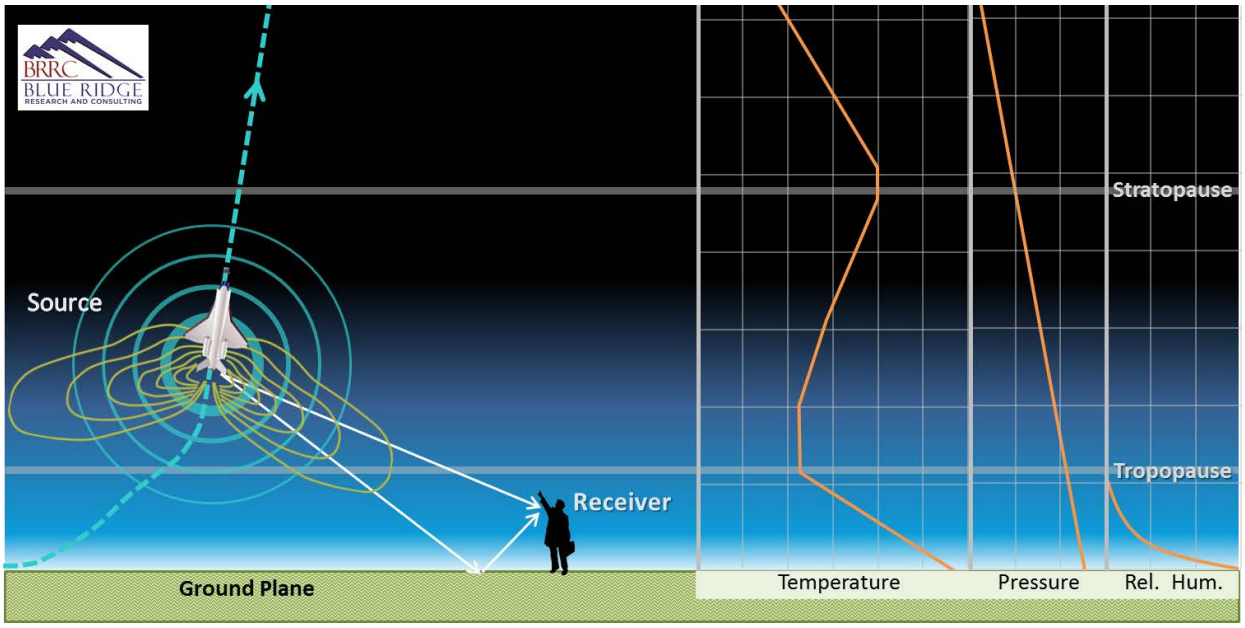

Figure 4-1. Conceptual overview of rocket noise prediction model methodology

4.1.1 Source

The rocket noise source definition considers the acoustic power of the rocket, forward flight effects, directivity, and the Doppler effect.

Acoustic Power

Eldred's Distributed Source Method 1 (DSM-1) [26] is utilized for the source characterization. The DSM-1 model determines the launch vehicle's total sound power based on its total thrust, exhaust velocity, and the engine/motor's acoustic efficiency. BRRC's recent validation of the DSM-1 model showed very good agreement between full-scale rocket noise measurements and the empirical source curves [27]. The

acoustic efficiency of the rocket engine/motor specifies the percentage of the mechanical power converted into acoustic power. The acoustic efficiency of the rocket engine/motor was modeled using Guest's variable acoustic efficiency [28]. Typical acoustic efficiency values range from 0.2% to 1.0% [26]. In the far-field, distributed sound sources are modeled as a single compact source located at the nozzle exit with an equivalent total sound power. Therefore, launch vehicle propulsion systems with multiple tightly clustered equivalent engines can be modeled as a single engine with an effective exit diameter and total thrust [26]. Additional boosters or cores (that are not considered to be tightly clustered) are handled by summing the noise contribution from each booster/core.

Forward Flight Effect

A rocket in forward flight radiates less noise than the same rocket in a static environment. A standard method to quantify this effect reduces overall sound levels as a function of the relative velocity between the jet plume and the outside airflow [29, 30, 31, 32]. This outside airflow travels in the same direction as the rocket exhaust. At the onset of a launch, the rocket exhaust travels at far greater speeds than the ambient airflow. Conversely, for a vertical landing, the rocket exhaust and ambient airflow travel in opposing directions, yielding an increased relative velocity differential. As the differential between the forward flight velocity and exhaust velocity decreases, jet plume mixing is reduced, which reduces the corresponding noise emission. Notably, the maximum sound levels are normally generated before the vehicle reaches the speed of sound. Thus, the modeled noise reduction is capped at a forward flight velocity of Mach 1.

Directivity

Rocket noise is highly directive, meaning the acoustic power is concentrated in specific directions, and the observed sound pressure will depend on the angle from the source to the receiver. NASA's Constellation Program has made significant improvements in determining launch vehicle directivity of the reusable solid rocket motor (RSRM) [33]. The RSRM directivity indices (DI) incorporate a larger range of frequencies and angles then previously available data. Subsequently, improvements were made to the formulation of the RSRM DI [34] accounting for the spatial extent and downstream origin of the rocket noise source. These updated DI are used for this analysis.

Doppler Effect

The Doppler effect is the change in frequency of an emitted wave from a source moving relative to a receiver. The frequency at the receiver is related to the frequency generated by the moving sound source and by the speed of the source relative to the receiver. The received frequency is higher (compared to the emitted frequency) if the source is moving towards the receiver, it is identical at the instant of passing by, and it is lower if the source is moving away from the receiver. During a rocket launch, an observer on the ground will hear a downward shift in the frequency of the sound as the distance from the source to receiver increases. The relative changes in frequency can be explained as follows: when the source of the waves is moving toward the observer, each successive wave crest is emitted from a position closer to the observer than the previous wave. Therefore, each wave takes slightly less time to reach the observer than the previous wave, and the time between the arrivals of successive wave crests at the observer is reduced, causing an increase in the frequency. While they are traveling, the distance between successive wave

fronts is reduced such that the waves "bunch together." Conversely, if the source of waves is moving away from the observer, then each wave is emitted from a position farther from the observer than the previous wave; the arrival time between successive waves is increased, reducing the frequency. Likewise, the distance between successive wave fronts increases, so the waves "spread out." Figure 4-2 illustrates this spreading effect for an observer in a series of images, where a) the source is stationary, b) the source is moving less than the speed of sound, c) the source is moving at the speed of sound, and d) the source is moving faster than the speed of sound. As the frequency is shifted lower, the A-weighting filtering on the spectrum results in a decreased A-weighted sound level. For unweighted overall sound levels, the Doppler effect does not change the levels since all frequencies are accounted for equally.

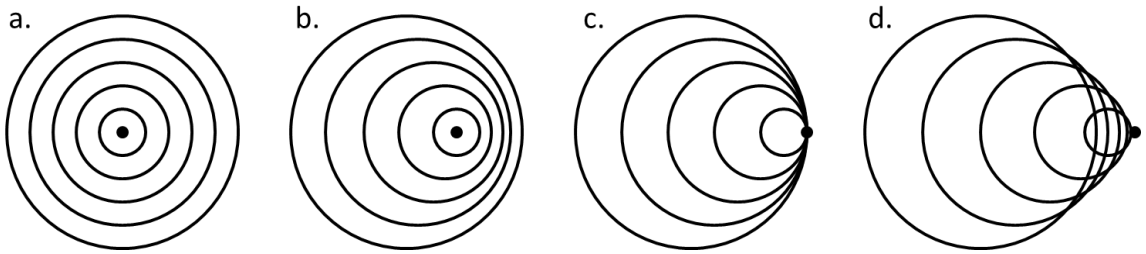

Figure 4-2. Effect of expanding wavefronts (decrease in frequency) that an observer would notice for higher relative speeds of the rocket relative to the observer for: a) stationary source b) source velocity < speed of sound c) source velocity = speed of sound d) source velocity > speed of sound

4.1.2 Propagation

The sound propagation from the source to receiver considers the ray path, atmospheric absorption, and ground interference.

Ray Path

The model assumes straight line propagation between the source and receiver to determine propagation effects. For straight rays, sound levels decrease as the sound wave propagates away from a source uniformly in all directions. The launch vehicle noise model components are calculated based on the specific geometry between source (launch vehicle trajectory point) to receiver (grid point). The position of the launch vehicle, described by the trajectory, is provided in latitude and longitude, defined relative to a reference system (e.g. World Geodetic System 1984) that approximates the Earth's surface by an ellipsoid. The receiver grid is also described in geodetic latitude and longitude, referenced to the same reference system as the trajectory data, ensuring greater accuracy than traditional flat earth models.

Atmospheric Absorption

Atmospheric absorption is a measure of the sound attenuation from the excitation of vibration modes of air molecules. Atmospheric absorption is a function of temperature, pressure, and relative humidity of the air. The propulsion noise model utilizes an atmospheric profile, which describes the variation of temperature, pressure, and relative humidity with respect to the altitude. Standard atmospheric data sources [35, 36, 37, 38] were used to create a composite atmospheric profile for altitudes up to 66 miles. The atmospheric absorption is calculated using formulas found in ANSI Standard S1.26-1995 (R2004). The result is a sound-attenuation coefficient, which is a function of frequency, atmospheric conditions, and distance from the source. The amount of absorption depends on the parameters of the atmospheric layer and the distance that the sound travels through the layer. The total sound attenuation is the sum of the absorption experienced from each atmospheric layer.

Nonlinear propagation effects can result in distortions of high-amplitude sound waves [39] as they travel through the medium. These nonlinear effects are counter to the effect of atmospheric absorption [40, 41]. However, recent research shows that nonlinear propagation effects change the perception of the received sound [42, 43], but the standard acoustical metrics are not strongly influenced by nonlinear effects [44, 45]. The overall effects of nonlinear propagation on high-amplitude sound signatures and their perception is an ongoing area of research, and it is not currently included in the propagation model.

Ground Interference

The calculated results of the sound propagation using DSM-1 provide a free-field sound level (i.e. no reflecting surface) at the receiver. However, sound propagation near the ground is most accurately modeled as the combination of a direct wave (source to receiver) and a reflected wave (source to ground to receiver) as shown in Figure 4-1. The ground will reflect sound energy back toward the receiver and interfere both constructively and destructively with the direct wave. Additionally, the ground may attenuate the sound energy, causing the reflected wave to propagate a smaller portion of energy to the receiver. RUMBLE accounts for the attenuation of sound by the ground [46, 47] when estimating the received noise. The model assumes a five-foot receiver height and a homogeneous grass ground surface. However, it should be noted that noise levels may be 3 dB louder over water surfaces compared to the predicted levels over the homogeneous grass ground surfaces assumed in the modeling. To account for the random fluctuations of wind and temperature on the direct and reflected wave, the effect of atmospheric turbulence is also included [46, 48].

4.1.3 Receiver

The received noise is estimated by combining the source and propagation components. The basic received noise is modeled as overall and spectral level time histories. This approach enables a range of noise metrics relevant to environmental noise analysis to be calculated and prepared as output.

4.2 Sonic Boom Modeling

A vehicle creates sonic booms during supersonic flight. The potential for the boom to intercept the ground depends on the trajectory and speed of the vehicle as well as the atmospheric profile. The sonic boom is shaped by the physical characteristics of the vehicle and the atmospheric conditions through which it propagates. These factors affect the perception of a sonic boom. The noise is perceived as a deep boom, with most of its energy concentrated in the low frequency range. Although sonic booms generally last less than one second, their potential for impact may be considerable.

A brief sonic boom generation and propagation modeling primer is provided in Section 4.2.1 to describe relevant technical details that inform the sonic boom modeling. The primer also provides visualizations of the boom generation, propagation, and ground intercept geometry. An overview of the sonic boom modeling software used in the study, PCBoom, and a description of inputs are found in Section 4.2.2.

4.2.1 Primer

When a vehicle moves through the air, it pushes the air out of its way. At subsonic speeds, the displaced air forms a pressure wave that disperses rapidly. At supersonic speeds, the vehicle is moving too quickly for the wave to disperse, so it remains as a coherent wave. This wave is a sonic boom. When heard at ground level, a sonic boom consists of two shock waves (one associated with the forward part of the vehicle, the other with the rear part) of approximately equal strength. When plotted, this pair of shock waves and the expanding flow between them has the appearance of a capital letter "N," so a sonic boom pressure wave is usually called an "N-wave." An N-wave has a characteristic "bang-bang" sound that can be startling. Figure 4-3 shows the generation and evolution of a sonic boom N-wave under the vehicle.

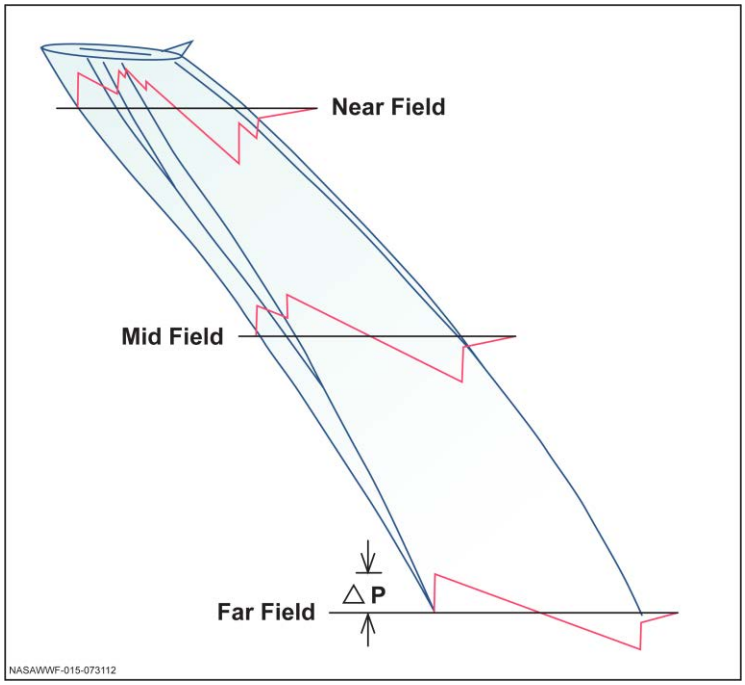

Figure 4-3. Sonic boom generation and evolution to N-wave [49]

For aircraft, the front and rear shock are generally the same magnitude. However, for rockets, in addition to the two shock waves generated from the vehicle body, the plume itself acts as a large supersonic body, and it generates two additional shock waves (one associated with the forward part of the plume, the other with the rear part) and extends the waveform duration to as large as one second. If the plume volume is significantly larger than the vehicle, its shocks will be stronger than the shocks generated by the vehicle.

Figure 4-4 shows the sonic boom wave cone generated by a vehicle in steady (non-accelerating) level supersonic flight. The wave cone extends toward the ground and is said to sweep out a "carpet" under the flight track. The boom levels vary along the lateral extent of the "carpet" with the highest levels directly underneath the flight track and decreasing levels as the lateral distance increases to the cut-off edge of the "carpet."

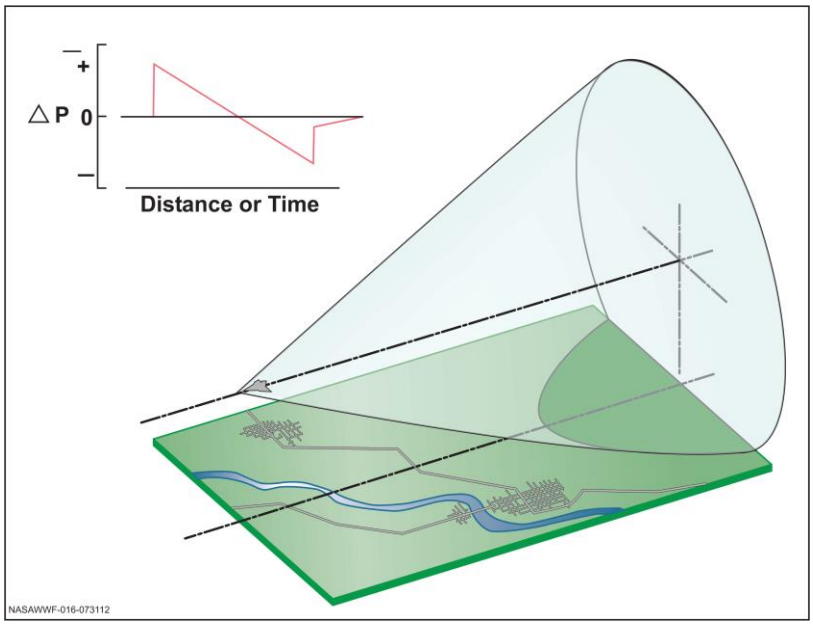

Figure 4-4. Sonic boom carpet for a vehicle in steady flight [50]

Although the wave cone can be calculated from an aircraft-fixed reference frame, the ray perspective is more convenient when computing sonic boom metrics in a ground-fixed observer's reference frame [51]. Both perspectives are shown in Figure 4-5. The difference in wave versus ray perspectives is described for level, climbing, and diving flight, in the PCBoom Sonic Boom Model User Guide [51]:

> Sonic boom wave cones are not generated fully formed at a single point in time, instead resulting from the accumulation of all previous disturbance events that occurred during the vehicle's time history. […] Unlike wave cones, ray cones are fully determined at a single point in time and are independent of future maneuvers. They are orthogonal to wave cones and represent all paths that sonic boom energy will take from the point they are generated until a later point in time when they hit the ground. The ray perspective is particularly useful when considering refraction due to atmospheric gradients or the effect of aircraft maneuvers, where rays can coalesce into high amplitude focal zones.

When the ray cone hits the ground, the resulting intersection is called an "isopemp." The isopemp is forward-facing [as shown in Figure 4-5] and falls a distance ahead of the vehicle called the "forward throw." At each new point in the trajectory, a new ray cone is generated, resulting in a new isopemp that strikes the ground. These isopemps are generated throughout the trajectory, sweeping out an area called the "boom footprint."

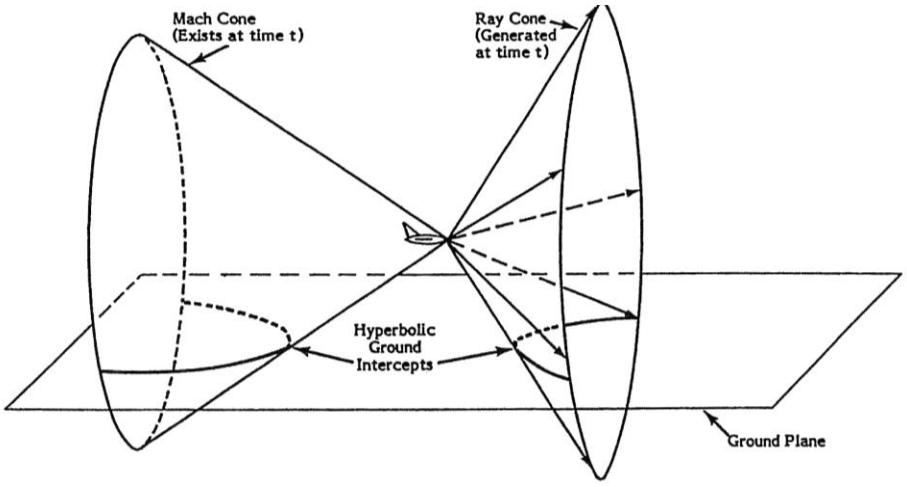

Figure 4-5. Mach cone vs ray cone viewpoints

Figure 4-4 and Figure 4-5 may give the impression that the boom footprint is generally associated with rays generated from the bottom of a vehicle. This is the case for vehicles at moderate climb and dive angles, or in level flight as shown in Figure 4-5. For a vehicle climbing at an angle steeper than the ray cone half angle, such as in the left image of Figure 4-6, rays from that part of its trajectory will not reach the ground. This is important for vertical launches, where the ascent stage of a launch vehicle typically begins at a steep angle. In these cases, sonic booms are not expected to reach the ground unless refracted back downwards by gradients in the atmosphere. Conversely, if a vehicle is in a sufficiently steep dive, such as in the right image of Figure 4-6, the entire ray cone may intersect the ground, resulting in an elliptical or even circular isopemp. This is of importance for space flight reentry analysis, where descent may be nearly vertical.

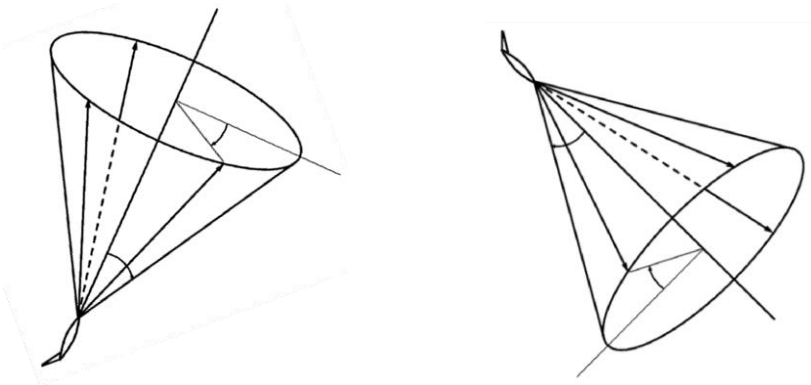

Figure 4-6. Ray cone in climbing (left) and diving (right) flight

4.2.2 PCBoom

The single-event prediction model, PCBoom [52, 53, 54], is a full ray trace sonic boom program that is used to calculate the magnitude, waveform, and location of sonic boom overpressures on the ground from supersonic flight operations. Additionally, PCBoom accounts for the effect of rocket exhaust plumes on the boom [55].

Several inputs are required to calculate the sonic boom impact, including the geometry of the vehicle, the trajectory path, and the atmospheric conditions. These parameters along with time-varying thrust, drag, and weight are used to define the PCBoom starting signatures used in the modeling. The starting signatures are propagated through the US Standard atmospheric profile.

5 Results

The following sections present the results of the environmental propulsion noise and sonic boom impacts associated with the proposed Firefly operations. Note, noise levels over water may be higher because of the acoustical hardness of the water surface. Single event and cumulative launch vehicle noise results are presented in Section 5.1 and Section 5.2, respectively.

5.1 Single Event Noise

Single event propulsion noise and sonic boom modeling results are presented in Sections 5.1.1 and 5.1.2, respectively.

5.1.1 Propulsion Noise

Individual launch site and static operations are evaluated using maximum A-weighted and unweighted sound levels for propulsion noise. The composite noise contour maps are provided representing the maximum sound levels over the range of launch azimuths proposed (between 44° and 110°).

Maximum A-weighted Sound Level ($L_{A,max}$)

The modeled $L_{A,max}$ contours associated with the launch and static fire operations at Firefly's CCAFS SLC-20 facility for each vehicle are presented in Figure 5-1 through Figure 5-4. An upper limit noise level of 115 dBA is used as a guideline to protect human hearing from long-term continuous daily exposures to high noise levels and to aid in the prevention of NIHL. The 115 dBA contours associated with the launch and static fire events are entirely within the boundaries of CCAFS. Thus, the potential for impacts to people in the community with regards to hearing conservation is negligible.

Launch Operations

The Alpha launch event generates modeled levels at or above an $L_{A,max}$ of 115 dBA within 0.3 miles of the launch site. The Beta launch event generates modeled levels at or above an $L_{A,max}$ of 115 dBA within 0.5 miles of the launch site. The 115 dBA contours for the Alpha and Beta launch events are shown in Figure 5-1 and Figure 5-2, respectively.

Static Fire Operations

The Alpha and Beta static fire event noise contours are more directive than the launch event noise contours because the plume is redirected in-line with the deflector heading. A receptor located along the peak directivity angle may experience an $L_{A,max}$ of 115 dBA at approximately 0.2 miles away from the Alpha and approximately 0.4 miles away from the Beta during a static fire event. The 115 dBA contours for the Alpha and Beta static fire events are shown in Figure 5-3 and Figure 5-4, respectively. Note, the levels produced by static fire events will remain constant over the duration of the event, whereas the levels produced by launch events will decrease as the rocket moves further away from the receptor.

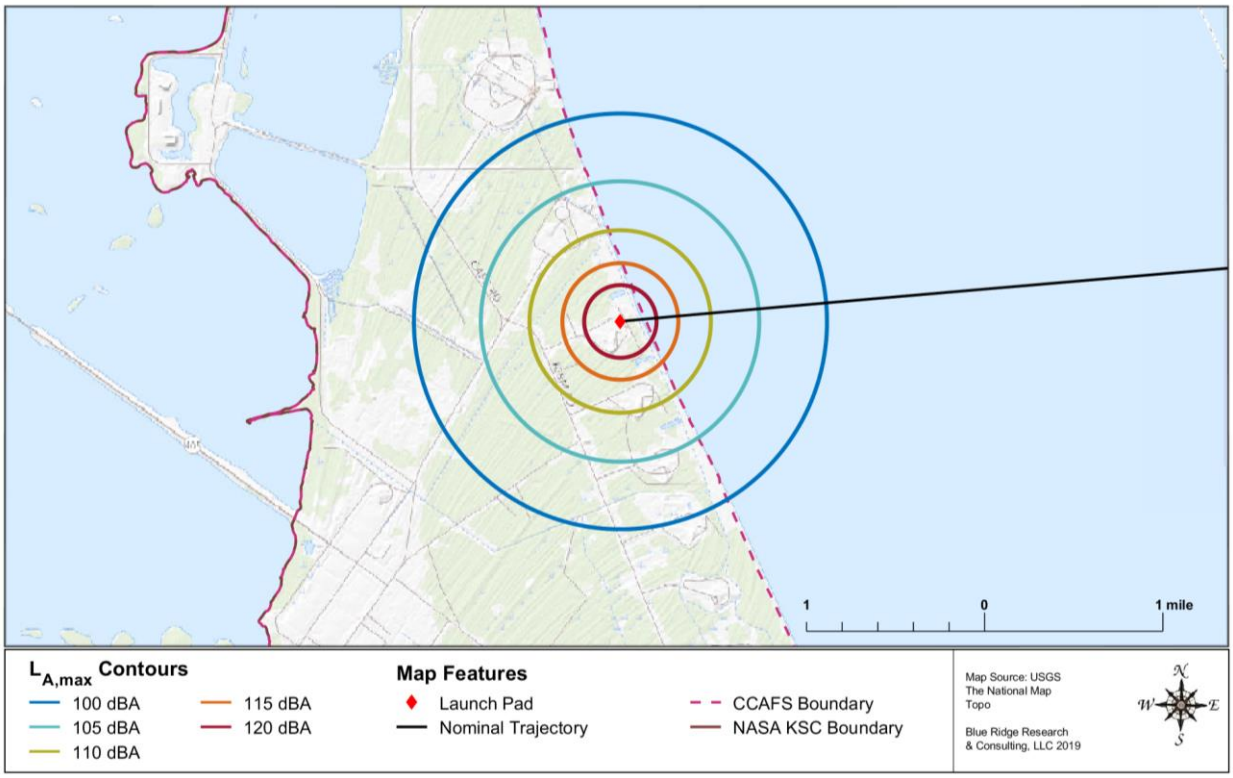

Figure 5-1. $L_{A,max}$ contours for the Alpha launch from Firefly's CCAFS SLC-20A

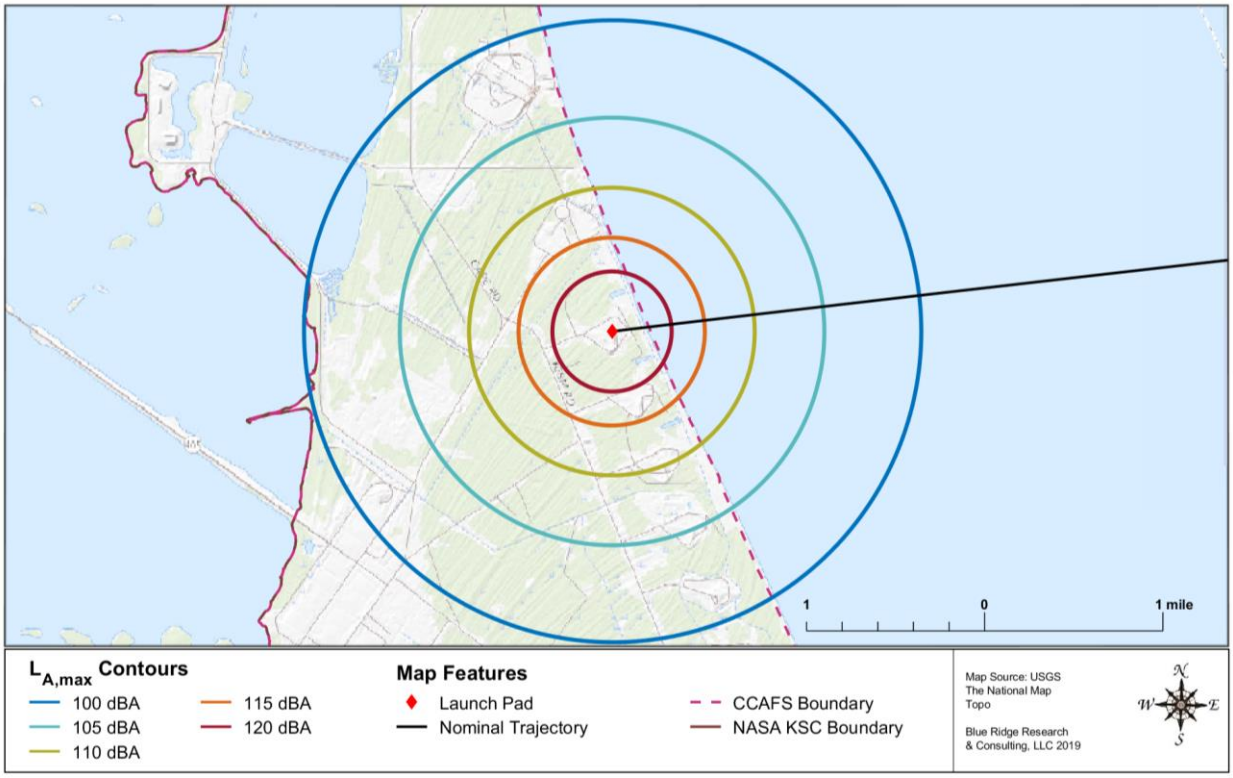

Figure 5-2. $L_{A,max}$ contours for the Beta launch from Firefly's CCAFS SLC-20B

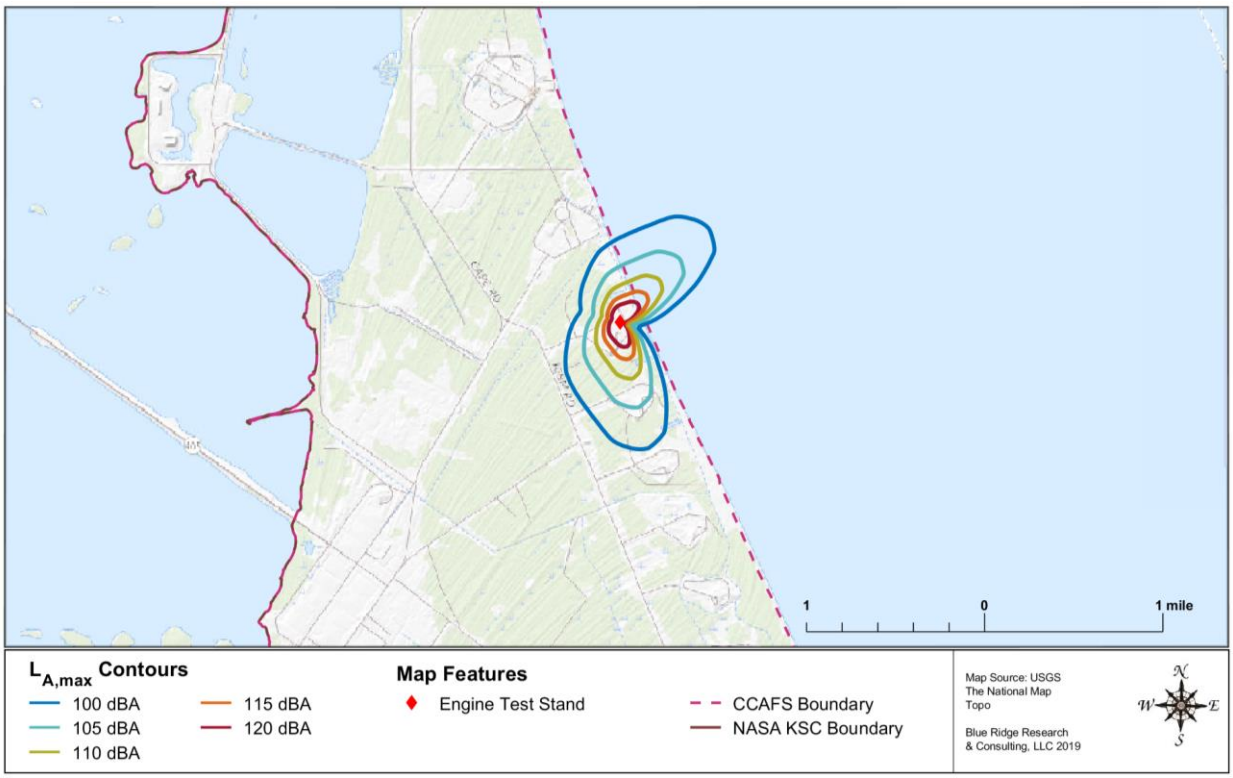

Figure 5-3. $L_{A,max}$ contours for all Alpha static fire operations at Firefly's CCAFS SLC-20A

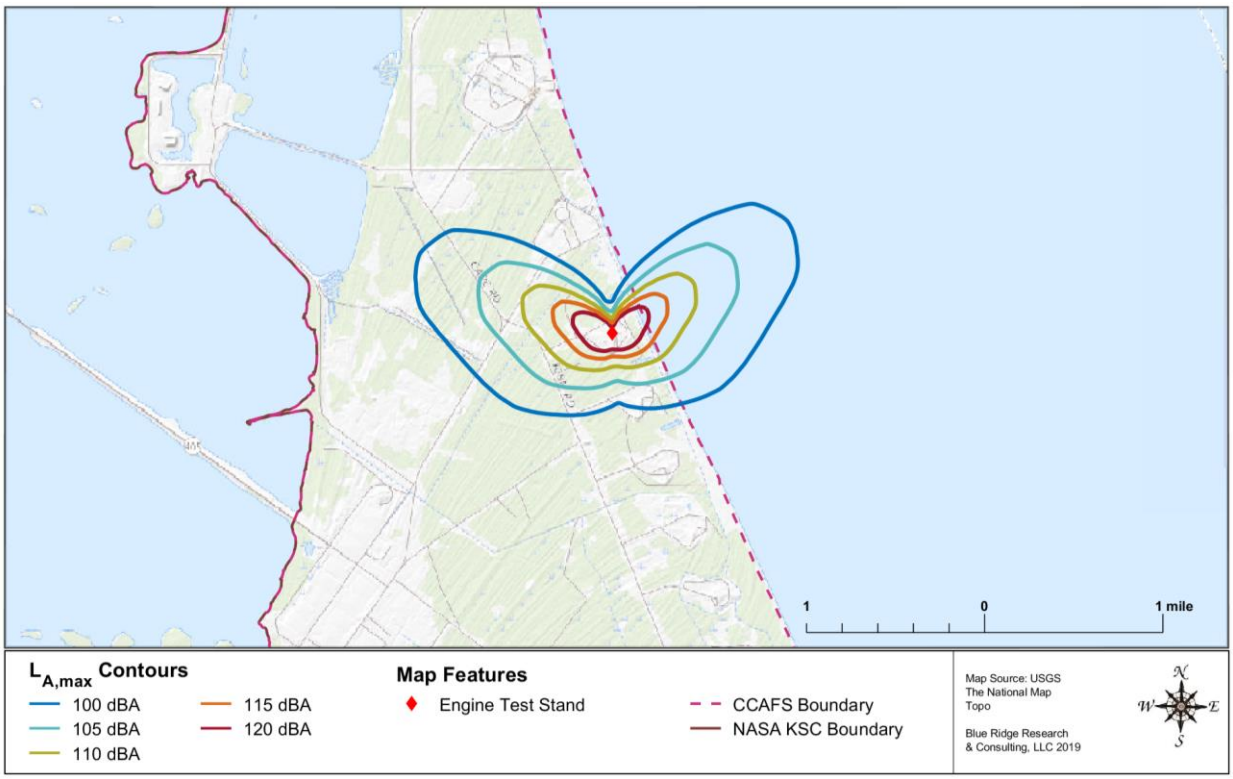

Figure 5-4. $L_{A,max}$ contours for all Beta static fire operations at Firefly's CCAFS SLC-20B

Maximum Unweighted Sound Level (L_{max})

The modeled L_{max} contours associated with the Alpha and Beta launch and static fire operations from Firefly's CCAFS SLC-20 facility are presented in Figure 5-5 through Figure 5-8. For reference, the potential for structural damage claims is approximately one damage claim per 100 households exposed at 120 dB and one in 1,000 households at 111 dB [21]. The entire land area encompassed by the 111 dB noise contours resulting from the Alpha and Beta launch or static fire events lies within the CCAFS and National Aeronautics and Space Administration (NASA) John F. Kennedy Space Center (KSC) boundaries.

Launch Site Operations

For the Alpha launch event, the modeled 120 dB and 111 dB L_{max} contours are limited to radii of 0.6 miles and 1.6 miles from the launch site, respectively, as shown in Figure 5-5. For the Beta launch event, the modeled 120 dB and 111 dB L_{max} contours are limited to radii of 1.5 miles and 4.0 miles from the launch site, respectively, as shown in Figure 5-6.

Static Fire Operations

For the Alpha static fire, a receptor located along the peak directivity angle may experience L_{max} values of 120 dB and 111 dB at approximately 0.6 miles and 1.5 miles from the launch site, respectively, as shown in Figure 5-7. For the Beta static fire, a receptor located along the peak directivity angle may experience L_{max} values of 120 dB and 111 dB at approximately 1.5 miles and 3.5 miles from the launch site, respectively, as shown in Figure 5-8.

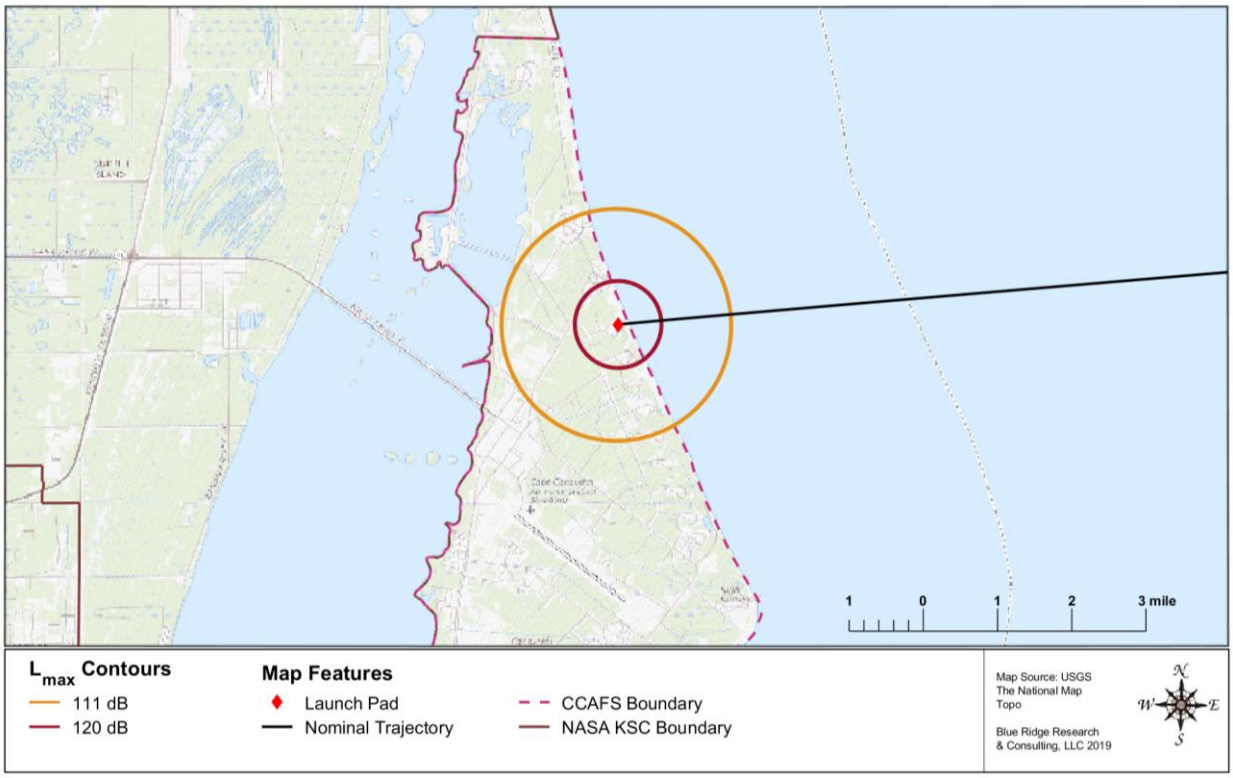

Figure 5-5. L_{max} contours for the Alpha launch from Firefly's CCAFS SLC-20A

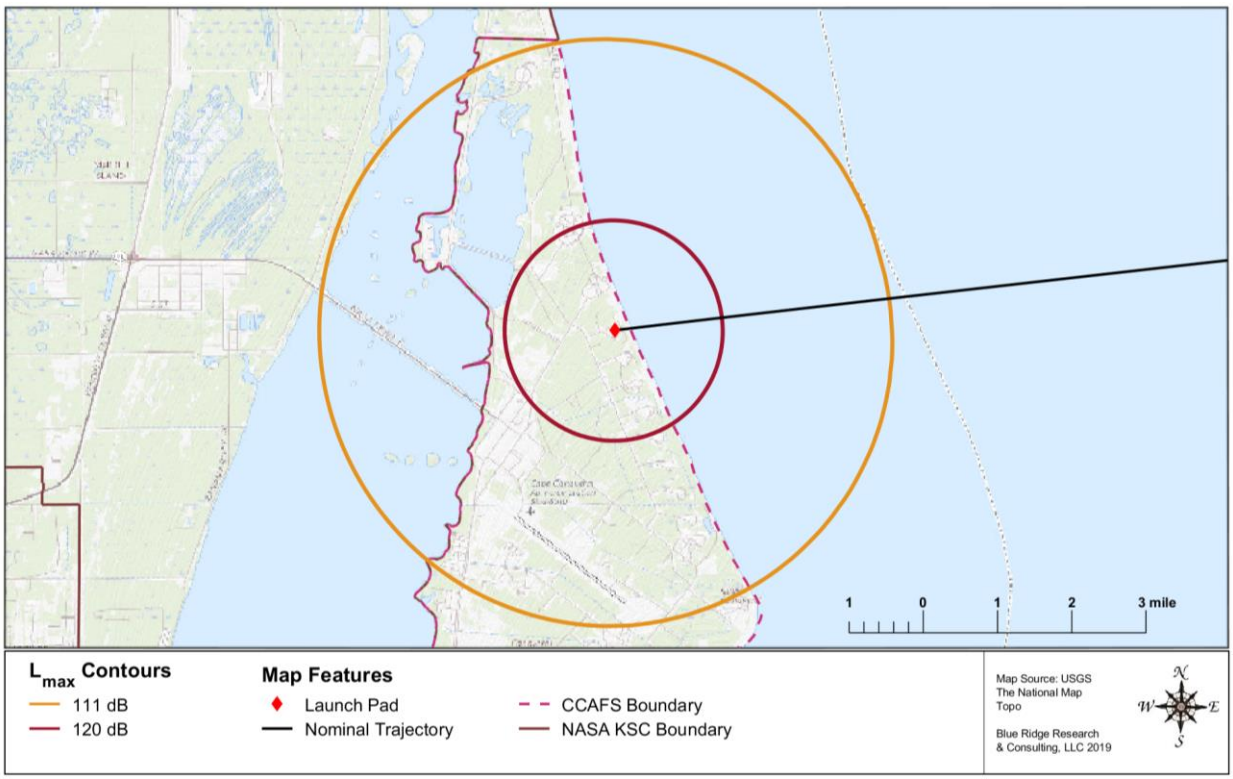

Figure 5-6. L_{max} contours for the Beta launch from Firefly's CCAFS SLC-20B

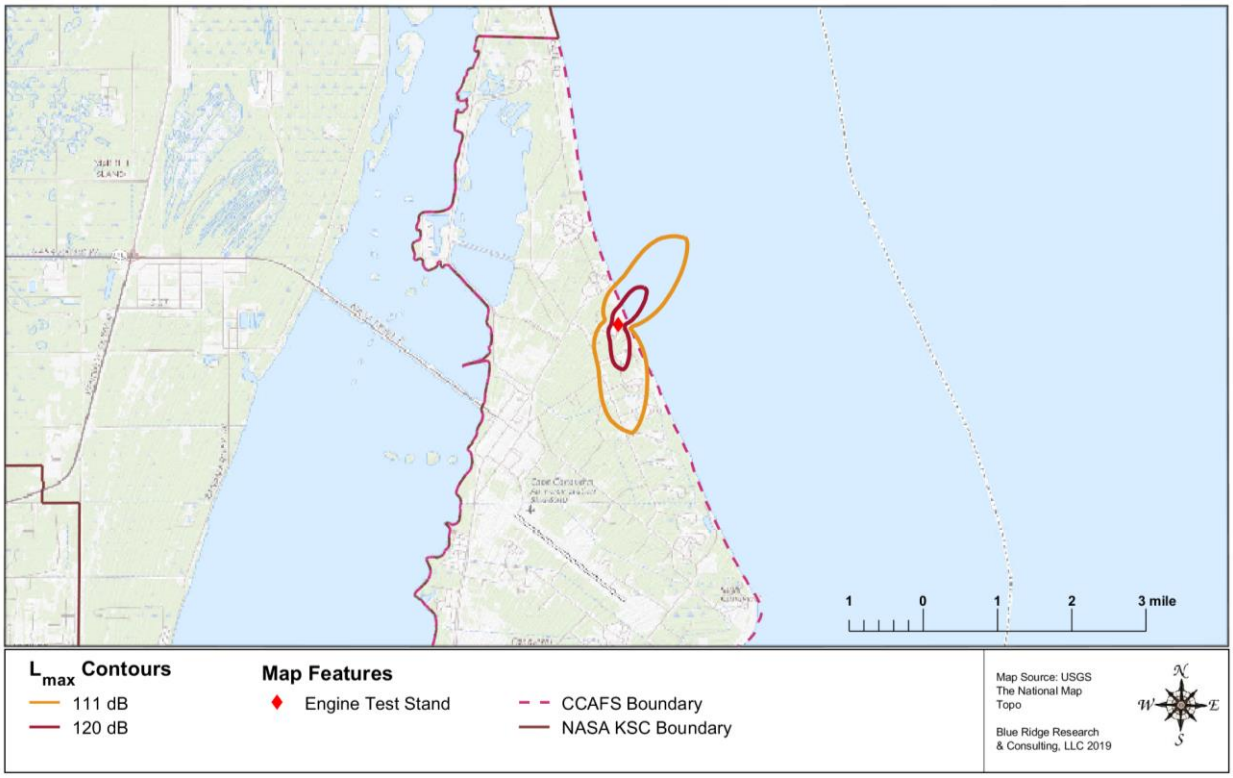

Figure 5-7. L_{max} contours for all Alpha static fire operations at Firefly's CCAFS SLC-20A

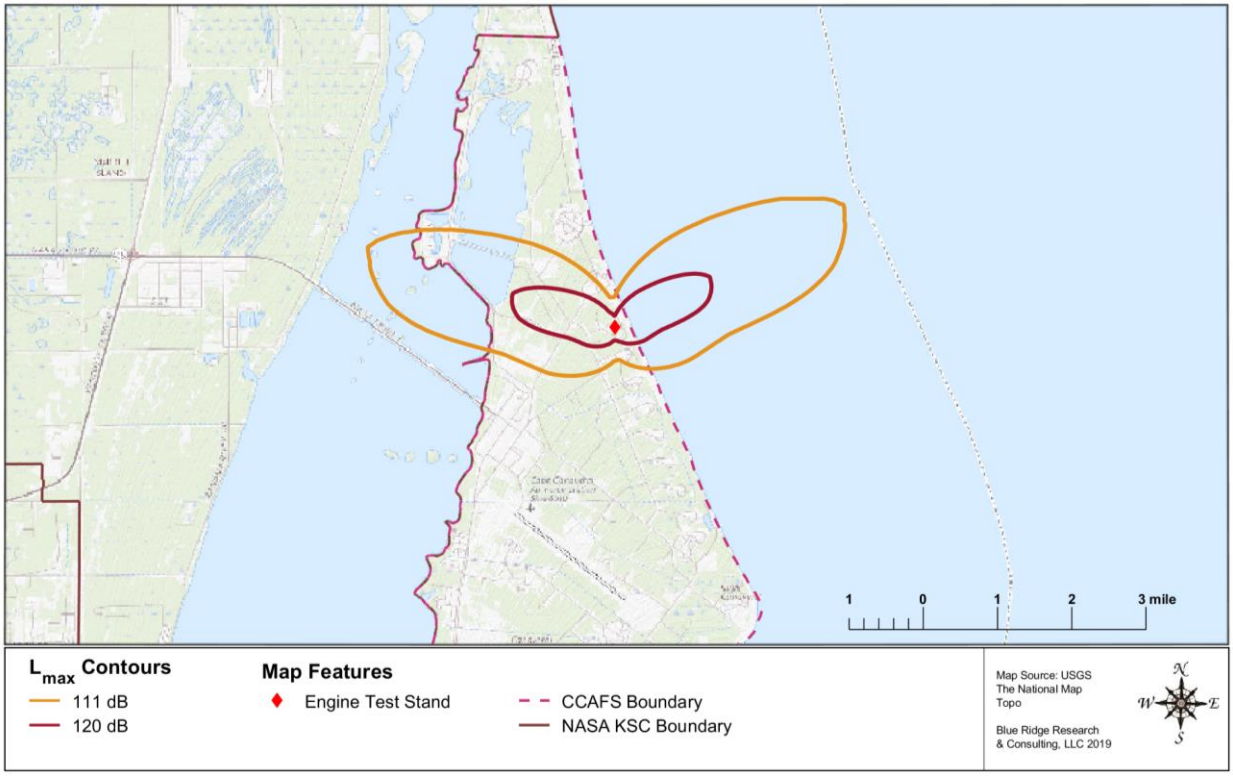

Figure 5-8. L_{max} contours for all Beta static fire operations at Firefly's CCAFS SLC-20A

5.1.2 Sonic Booms

Individual launch site operations are evaluated using maximum peak overpressure for sonic booms.

Maximum Peak Overpressure (psf)

The modeled sonic boom peak overpressure contours for typical Alpha and Beta launch operations are presented in Figure 5-9 and Figure 5-10, respectively. The sonic booms were modeled based on Alpha and Beta launch trajectories at a nominal azimuth of 85° relative to true north. The sonic booms produced by the Alpha and Beta launch vehicles have long, narrow, forward-facing, crescent-shaped focus boom regions 37 and 44 miles downrange of the launch site, respectively. These focus boom regions are generated because the rocket continuously accelerates and pitches downward as it ascends. The maximum peak overpressures along the focus boom regions for the Alpha and Beta launch vehicles are predicted to be approximately 6.1 psf and 7.4 psf, respectively. However, these levels would only occur in extremely small areas along the focus boom regions. As the rocket gains altitude, the sonic boom peak overpressure gradually decreases, and the crescent-shaped contours become slightly wider.

To determine the sonic boom peak overpressure contours over the range of proposed launch azimuths, the 85° nominal trajectory was rotated to create composite contours. To facilitate visualization of the effect of rotation, an intermediate illustration of the 44°, 85°, and 110° trajectories is shown for Alpha and Beta launches in Figure 5-11 and Figure 5-12, respectively. A bounding line is shown in gray to demonstrate the overall extents of the contours obtained from the rotated trajectories.

The composite contours shown in Figure 5-13 and Figure 5-14 for the Alpha and Beta launch operations, respectively, represent the maximum peak overpressure that may occur due to Alpha and Beta launch operations at any azimuth between 44° and 110°. The banding of contour levels shown in Figure 5-13 is a result of the narrow focal zones. Note, sonic booms produced by a single launch event will not be audible over the entire contour areas shown in Figure 5-13 and Figure 5-14, but they will impact somewhere within these contour areas, with the specific locations determined by the launch azimuth. As discussed previously, the potential remains for elevated levels within small focal regions.

The locations of the sonic boom footprints produced by Alpha and Beta launch operations will be highly dependent on the vehicle configuration, trajectory, and atmospheric conditions at the time of flight. However, the sonic booms resulting from Alpha and Beta launch operations are predicted to occur over the Atlantic Ocean for all proposed launch azimuths between 44° and 110°. Thus, no noise impacts with respect to human annoyance, health and safety, or structural damage are expected due to the sonic booms produced by Alpha and Beta launch operations.

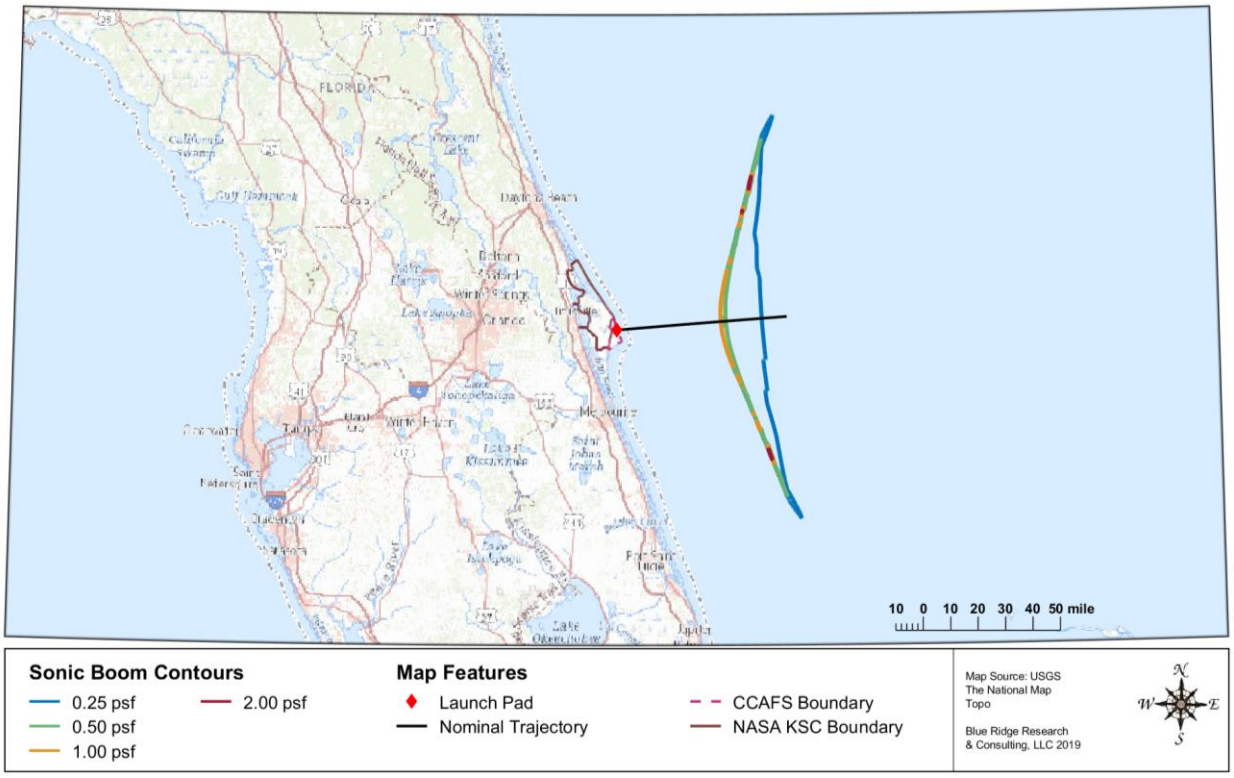

Figure 5-9. Sonic boom peak overpressure contours for a nominal Alpha launch from SLC-20A

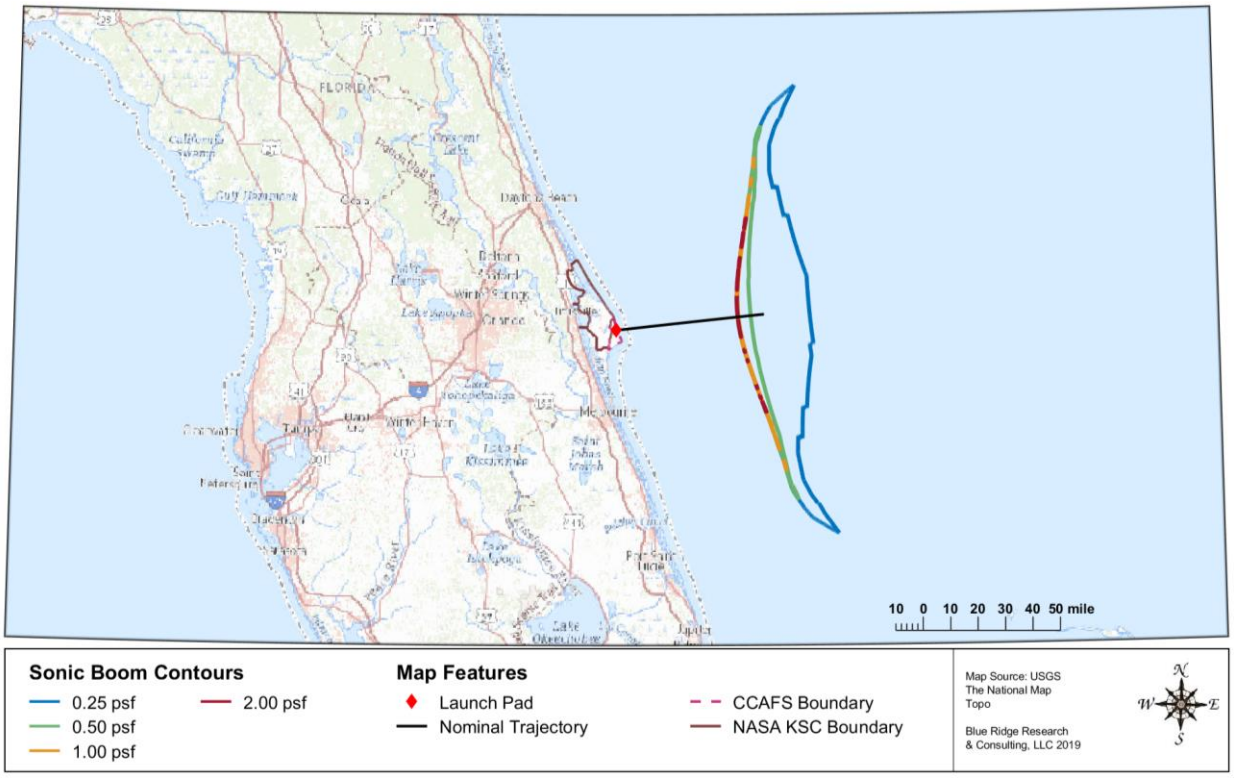

Figure 5-10. Sonic boom peak overpressure contours for a nominal Beta launch from SLC-20B

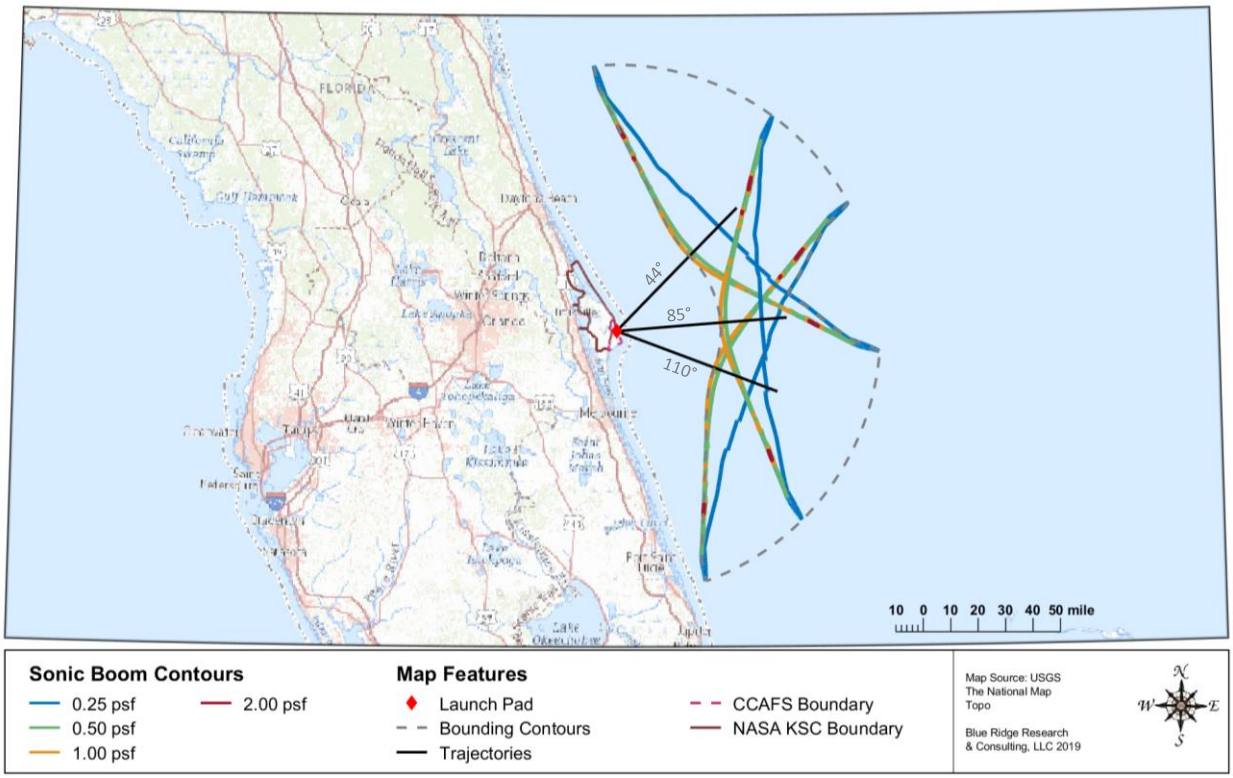

Figure 5-11. Sonic boom peak overpressure contours for 44°, 85°, and 110° Alpha launches from SLC-20A

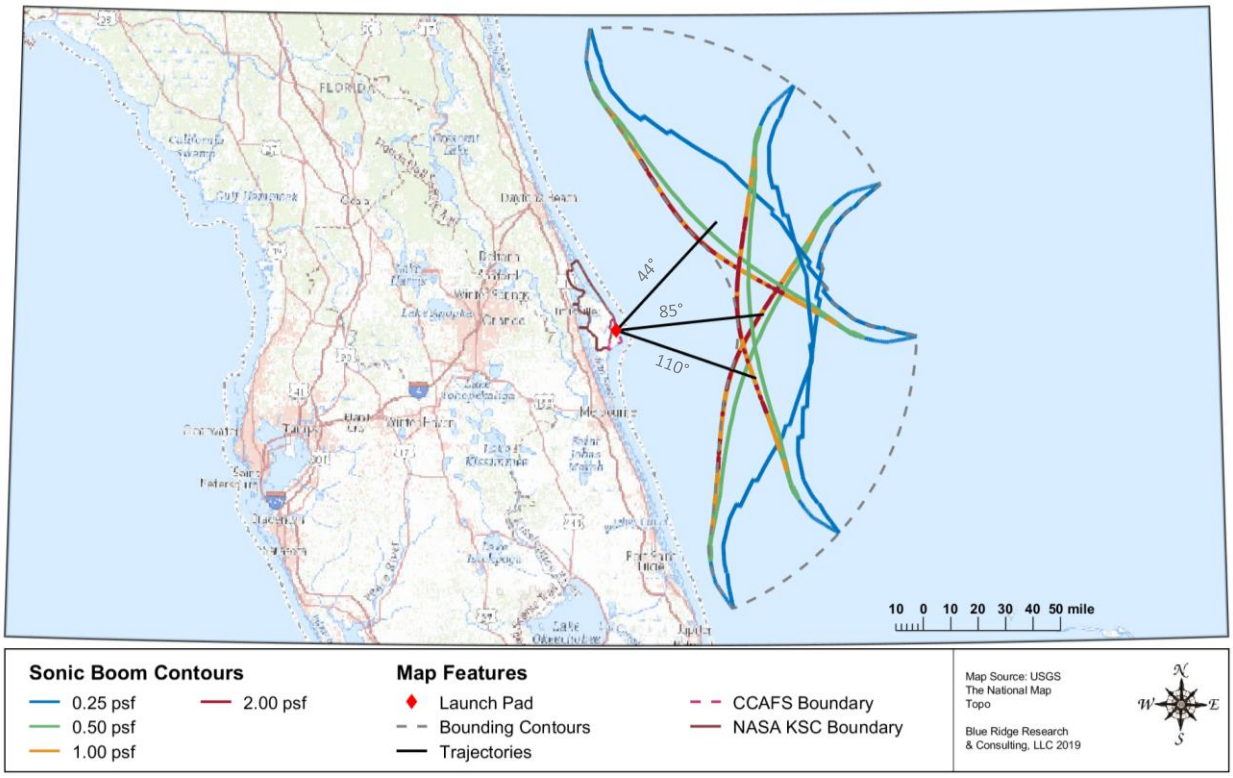

Figure 5-12. Sonic boom peak overpressure contours for 44°, 85°, and 110° Beta launches from SLC-20A

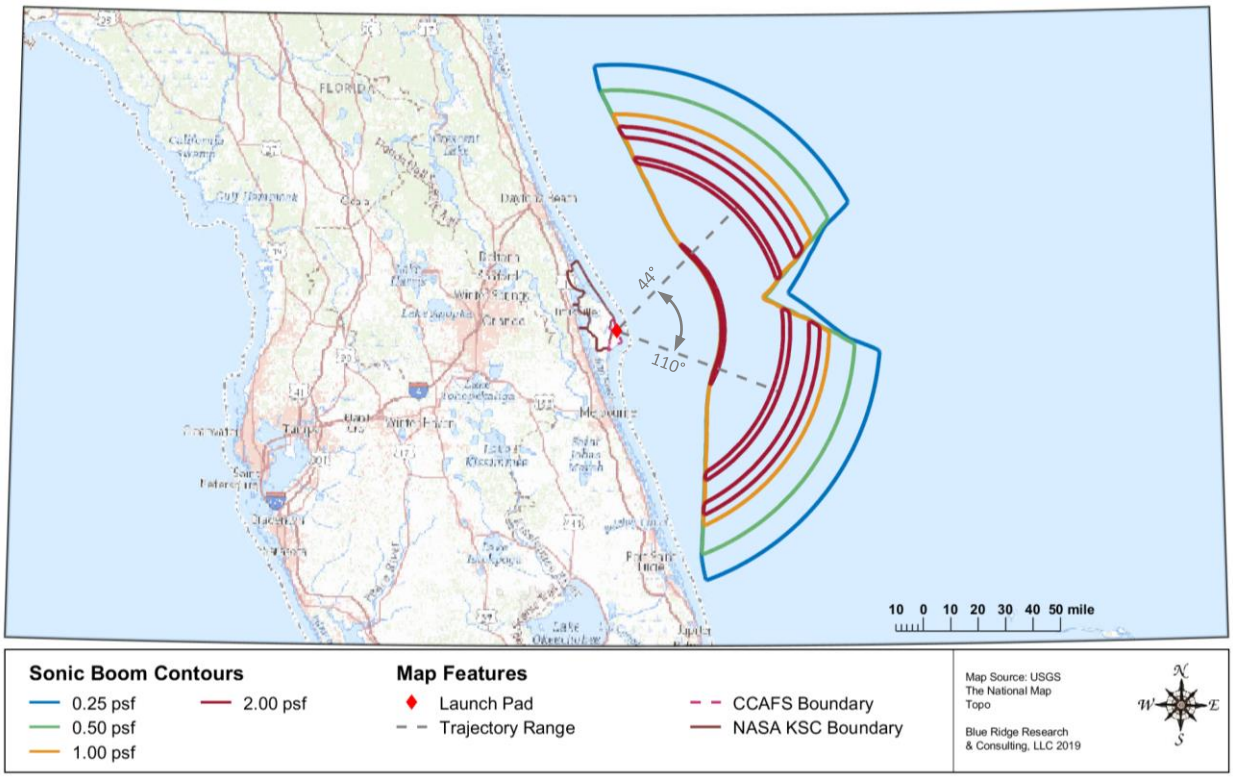

Figure 5-13. Maximum sonic boom peak overpressure contours for Alpha launches from SLC-20A

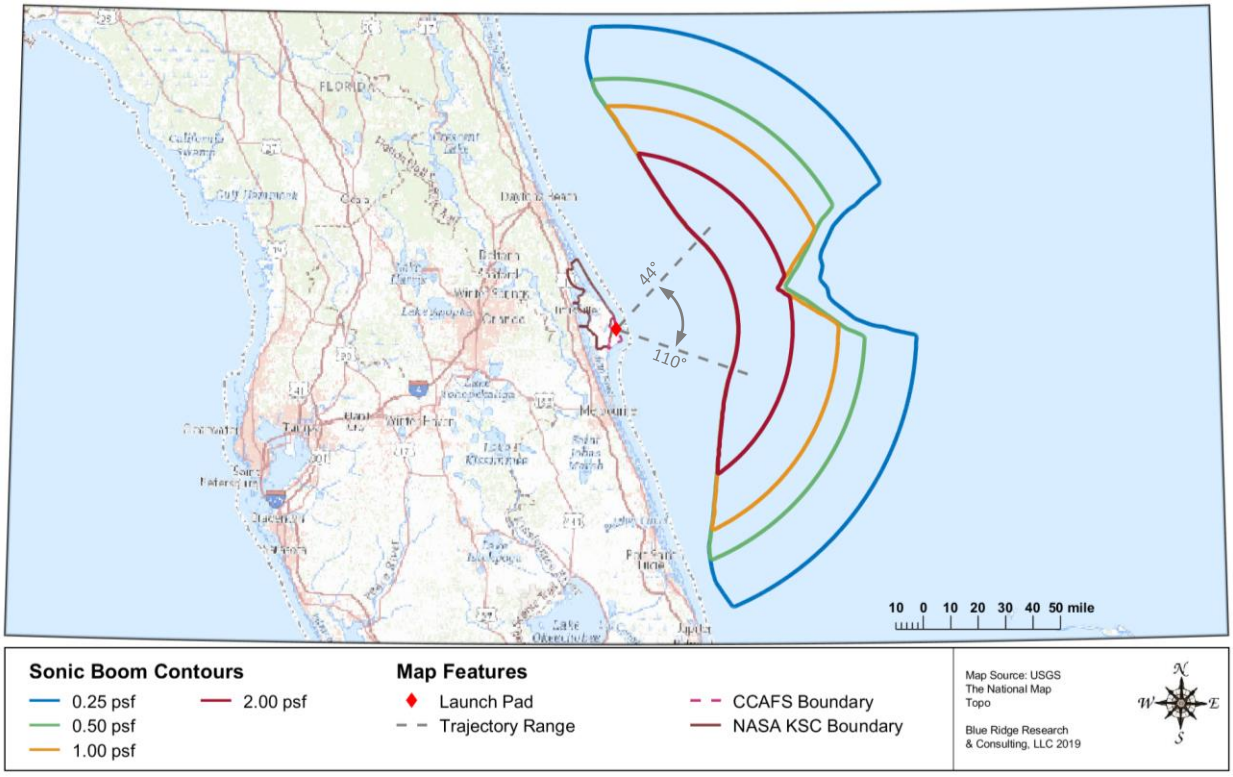

Figure 5-14. Maximum sonic boom peak overpressure contours for Beta launches from SLC-20B

5.2 Cumulative Noise

The potential for long-term community annoyance is assessed using A-weighted DNL for launch vehicle noise and C-weighted DNL for sonic booms. Alpha and Beta launch operations are considered over a range of launch azimuths between 44° and 110°.

Launch Site Operations

The DNL 60 dBA contour is used to conservatively identify the potential for significant noise impacts, as 60 dBA is the smallest level that could "increase noise by DNL 1.5 dB[A] or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dB[A] noise exposure level, or that will be exposed at or above this level due to the increase" [11]. The DNL contours from 60 dBA to 75 dBA are presented in Figure 5-15. The DNL 65 and 60 dBA contours extend approximately 1.2 and 1.8 miles from the launch pad, respectively. This area does not encompass land outside of the boundaries of CCAFS and NASA KSC, and, thus, no residences are impacted.

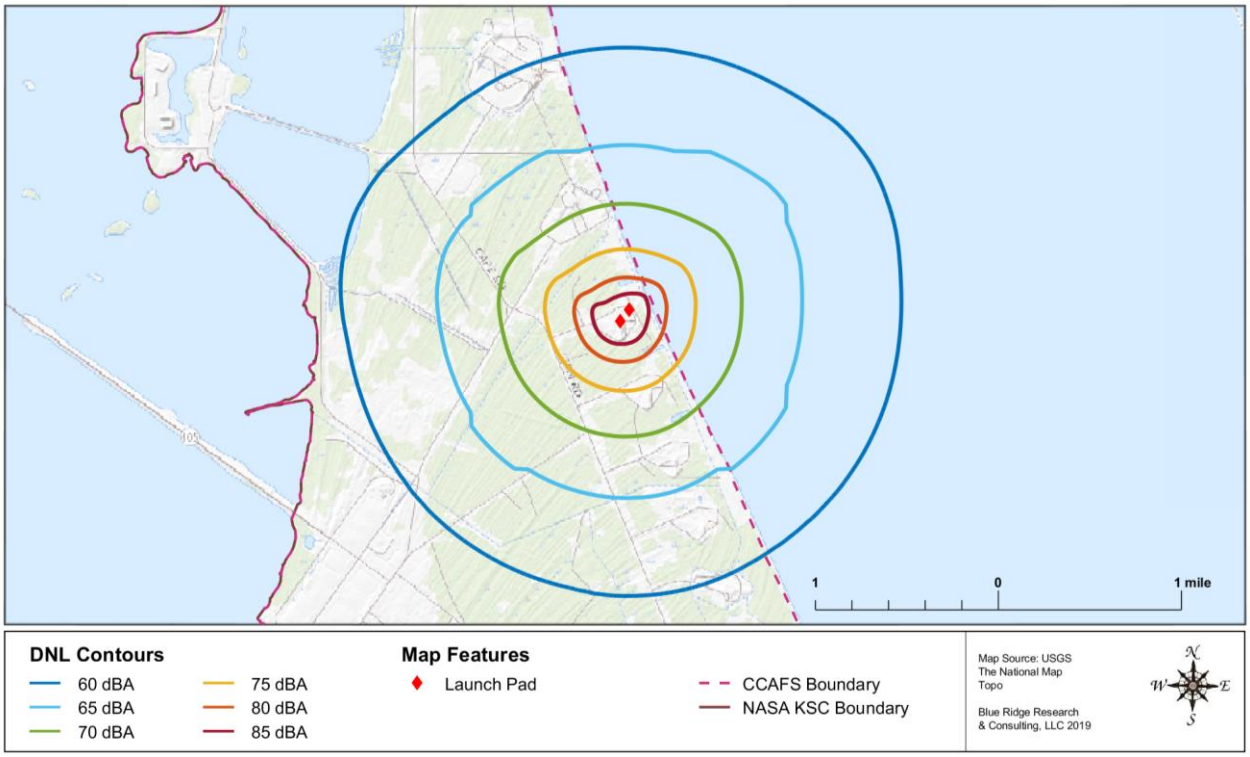

Figure 5-15. DNL contours for launch and static fire operations for both Alpha and Beta vehicles at Firefly's CCAFS SLC-20

The presence and/or location of sonic booms from Firefly launches will be highly dependent on the vehicle configuration, trajectory, and atmospheric conditions at the time of flight. However, the sonic booms resulting from the range of proposed launch trajectories would be directed easterly out over the Atlantic Ocean in the direction of the launch azimuth, making them inaudible on the mainland. Therefore, with respect to human annoyance, health and safety, or structural damage; noise impacts due to sonic booms for the launch trajectory are not expected. Thus, a quantitative analysis was not performed.

6 Summary

This report documents the noise study performed as part of the EA for Firefly's CCAFS SLC-20 Facility. Firefly plans to conduct Alpha operations for up to 10 pre-launch static fire engine tests, 24 acceptance static fire engine tests, and 10 vertical launches per year. Beta operations are planned for up to 18 pre-launch static fire engine tests, 24 acceptance static fire engine tests, and 18 vertical launches per year. Both the static fire and launch events will occur at Firefly's CCAFS SLC-20 Facility. The potential impacts from propulsion noise and sonic boom are evaluated on a single-event and cumulative basis in relation to hearing conservation, structural damage, and human annoyance.

Single Event Noise Results with respect to Hearing Conservation

An upper limit noise level of $L_{A,max}$ 115 dBA is used as a guideline to protect human hearing from long-term continuous daily exposures to high noise levels and to aid in the prevention of NIHL. The 115 dBA contours associated with the launch and static fire events are entirely within the boundaries of CCAFS.

For impulsive noise events such as sonic booms, noise impacts to human annoyance and health and safety are not expected. Thus, the potential for impacts to people in the community with regards to hearing conservation is negligible

Single Event Noise Results with respect to Structural Damage

The potential for structural damage claims is approximately one damage claim per 100 households exposed at 120 dB and one in 1,000 households at 111 dB [21]. The entire land area encompassed by the 111 dB noise contours resulting from the Alpha and Beta launch or static fire events lies within CCAFS/KSC boundaries.

For impulsive events such as sonic booms, there is potential for structural damage (to glass, plaster, roofs, and ceilings) for well-maintained structures for overpressure levels greater than 2 psf. Modeled sonic boom overpressure levels between 2 and 4 psf are directed easterly out over the Atlantic Ocean in the direction of the launch azimuth, making them inaudible on the mainland. Thus, the potential for impacts with regards to structural damage is negligible

Cumulative Noise Results

The DNL 60 dBA contour is used to conservatively identify the potential for significant noise impacts. The area identified within the 60 dBA contour for cumulative noise does not encompass land outside of the boundaries of CCAFS and NASA KSC, and, thus, no residences are impacted.

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APPENDIX C

USFWS Biological Opinion

United States Department of the Interior

FISH AND WILDLIFE SERVICE
North Florida Ecological Services
7915 BAYMEADOWS WAY, SUITE 200
JACKSONVILLE, FLORIDA 32256-7517

FWS Log No. 04EF1000-2020-F-0288

April 23, 2020

Mr. Michael Blaylock, Chief, Environmental Conservation
Department of the Air Force, 45th Space Wing
45 CES/CEIE
1224 Jupiter Street
Patrick AFB, Florida 32925
(Attn: Angy Chambers)

Subject: Space Florida LC-20

Dear Mr. Blaylock:

This letter acknowledges the U.S. Fish and Wildlife Service (Service) has reviewed the consultation request and the supporting Biological Assessment (EA) for Space Florida's Launch Complex-20 (SLC-20) Construction and Operations at Cape Canaveral Air Force Station (CCAFS), Brevard County, FL. The 45th Space Wing (SW) has prepared a BA pursuant to section 7 of the Endangered Species Act of 1973 (Act) (16 U.S.C. 1531 *et seq*.) and is requesting our concurrence and formal consultation for the proposed modifications at SLC-20.

Some of the information needed to initiate consultation was included with your request received on October 18, 2019, or was supplied in a supplemental BA provided on March 5, 2020. The 45th SW has revised the effects determination for eastern indigo snake (*Drymarchon corais couperi*) and Florida Scrub-Jay *(Aphelocoma coerulescens*).

Section 7 allows the Service up to 90 calendar days to conclude formal consultation with your agency and an additional 45 days to prepare our biological opinion (unless we mutually agree to an extension). Under the revised regulations 50 CFR §402.16, reinitiating criteria is clarified to include informal consultations.

The 45th SW has determined that the Action may affect, and is likely to adversely affect southeastern beach mice (*Peromyscus polionotus niveiventris)*. The Service has received the information for the formal consultation request in the amended BA. In the amended BA, the Service was provided an updated map for the proposed southeastern beach mouse habitat enhancement area for the pending biological opinion and an updated effects analysis for the following species.

Florida Scrub-Jay

The 45th SW is revising its approach with current and future users to ensure burn windows occur annually to prioritize prescribed fire management goals. The 45th SW is working with senior CCAFS environmental staff to develop operational controls. These operational controls will block out a set number of days annually within which launches or other activities affected by prescribed burns cannot occur. Designated burn windows will allow SW to meet its habitat management goals agreed to with the resource agencies. Space Florida will incorporate language into their tenant lease agreements that reference the prescribed burn goal, listed species management responsibilities, and resulting annual restrictions (1-2 weeks) during a 45th SW predefined period. As part of the lease agreement with Space Florida, the tenants will have a contractual obligation to comply with the specified prescribed burn days schedule by providing adequate protection for their equipment (via containment or filtration systems) or moving sensitive equipment to another location while the prescribed burn days are in force.

In summary, the Service concurs with the revised determination based on the following revisions in the BA:

1) Schedule operational controls that will provide assurances that 45th SW can meet the land management responsibilities;
2) Space Florida's lease agreements that the proposed processing facility shall accommodate smoke or move sensitive equipment to another location; and
3) the loss of 0.3 acres marginal coastal scrub habitat will have a discountable impact overall to the species management.

Eastern Indigo Snake

The 45th SW has agreed to implement the *Standard Protection Measures for Eastern Indigo Snakes* (SPM) to minimize any potential effects on the species. The eastern indigo snake has been observed on Cape Canaveral but has not been documented in the LC-20 project area. Scoping of burrows before collapsing will ensure that the species is not entombed during the collapse of refugia. Although eastern indigo snakes are vulnerable during construction activities, the SPM will educate construction personnel. If any indigo snakes are encountered during clearing activities, they will be allowed to move out of the project area safely and the 45th SW will contact the Service per the SPM.

Thank you for the request for formal consultation and revised BA, we expect to provide you with our biological opinion not later than July 16, 2020. For any questions about our concurrence letter, please contact Ms. Tera Baird by phone at 904-731-3196 or by email at tera_baird@fws.gov.

Sincerely,

Jay B. Herrington
Field Supervisor

United States Department of the Interior

FISH AND WILDLIFE SERVICE
North Florida Ecological Services
7915 BAYMEADOWS WAY, SUITE 200
JACKSONVILLE, FLORIDA 32256-7517

FWS Log No. 04EF1000-2020-F-0288

July 13, 2020

Mr. Michael Blaylock
Chief, Environmental Conservation
45 CES/CEIE-Cape

Subject: Space Florida Launch Complex 20

Dear Mr. Blaylock:

This letter transmits the U.S. Fish and Wildlife Service's (Service) biological opinion (BO) for Space Florida's Construction and Operations at Space Launch Complex-20 (SLC-20 or Action) at Cape Canaveral Air Force Station (CCAFS), Brevard County, FL. The 45th Space Wing (SW) prepared a Biological Assessment pursuant to section 7 of the Endangered Species Act of 1973 (Act) (16 U.S.C. 1531 *et seq*.) and requested formal consultation for the proposed modifications at SLC-20 and the anticipated effects of the Action on southeastern beach mice (*Peromyscus polionotus niveiventris*).

The transmitted BO considers the effects of the Action on southeastern beach mice. The Action does not affect designated critical habitat; therefore, this BO does not address critical habitat. The Service has determined that the proposed action will not jeopardize the continued existence of the southeastern beach mouse.

The SW determined that the Action may affect, but is not likely to adversely affect the West Indian manatee (*Trichechus manatus latirostris*), Wood stork (*Myteria americana*), Piping plover (*Charadrius melodus)*, Red knot *(Calidris canutus*), eastern indigo snake (*Drymarchon corais couperi*) and Florida Scrub-Jay (*Aphelocoma coerulescens)*. The Service concurred with the determinations for the first four species in a letter dated February 10, 2020 and concurred on the remaining two species in a letter dated April 23, 2020.

The SW has determined that the Action may affect, and is likely to adversely affect the following nesting marine turtles: leatherback (*Dermocheuls coriacea*), green (*Chelona mydas*), loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*), and hawksbill (*Eretmochelys imbricata*). The Service has analyzed programmatically the effects of facility lighting adjacent to nesting marine turtle habitat and has exempted incidental take under the BO, FWS Log. 2009-F-0087.

The applicant and the SW have agreed to implement the measures outlined in the BO and the Service has determined programmatically that such actions that implement all the terms and conditions of the BO will not jeopardize the continued existence of nesting marine turtles.

Thank you for requesting consultation with the Service. If you have any questions about the BO, please contact Ms. Tera Baird by email at tera_baird@fws.gov or by phone at 904-731-3196.

Sincerely,

Acting for:
Jay B. Herrington
Field Supervisor

Biological Opinion

For Space Launch Complex -20
At Cape Canaveral Air Force Station

FWS Log #: 04EF1000-2020-F-0288

Prepared by:

U.S. Fish and Wildlife Service
North Florida Ecological Services
7915 Baymeadows Way, Suite 200
Jacksonville, FL 32256

Acting For _____ _____

Jay B. Herrington - Field Supervisor Date

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CONSULTATION HISTORY

This section lists key events and correspondence during this consultation. A complete administrative record of this consultation is on file in the U.S. Fish and Wildlife North Florida Ecological Services' Office (Service).

2019-09-27 - 45th Space Wing (SW) sent a biological assessment (BA) requesting formal consultation for southeastern beach mouse (*Peromyscus polionotus niveiventris*), eastern indigo snake (*Drymarchon corais couperi*) and Florida Scrub-Jay (*Aphelocoma coerulescens*).

2020-12-06 - Air Force liaison and Service biologist had a call with the SW to discuss two projects, Space Florida Launch Complex-20, Space Florida Launch Complex-16, and the proposed compensation. AF Liaison discussed swapping the proposed compensation to support southeastern beach mice habitat restoration near the launch pads and an opportunity to collaborate with Florida Fish and Wildlife Commission to monitor the beach mice near the launch facilities.

2020-01-15 - SW sent a revised BA with changes to the project description and requested consultation on the following species: marine turtles: leatherback *(Dermocheuls coriacea*), green (*Chelona mydas*), loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*), and hawksbill *(Eretmochelys imbricata)*, southeastern beach mouse (*Peromyscus polionotus niveiventris*), Florida Scrub-Jay (*Aphelocoma coerulescen*s), eastern indigo snake (*Drymarchon corais couperi*), West Indian manatee (*Trichechus manatus latirostris*), Wood stork (*Mycteria americana*), Piping plover (*Charadrius melodus*), and Red knot (*Calidris canutus*). The BA also addressed the candidate species, gopher tortoise (*Gopherus polyphemus*).

2020-02-05 – SW sent an email with the proposed area for southeastern beach mouse habitat enhancement at land management unit 27.

2020-02-11- SW sent an email with the revised map for southeastern beach mouse habitat enhancement/restoration compensation. Habitat enhancement area is between Space Launch Complex-16 and Space Launch Complex-19.

2020-02-18 - The Service sent a concurrence letter dated February 10, 2020, for the following species: marine turtles (leatherback, green, Kemp's ridley, and hawksbill), West Indian manatee, Wood stork, Piping plover, and Red knot. The letter requested more information to support the effect determination for the Florida Scrub-Jay and eastern indigo snake.

2020-02-24- AF Liaison and Florida Scrub-Jay recovery biologists met with the SW and members of the space industry, including Space Florida, to discuss future compatibility of prescribed fire habitat management and operations of the launch facilities.

2020-03-05 – SW revised BA with an updated determination for Florida Scrub-Jay and eastern indigo snake. The BA has described that SW will establish an operational window for prescribed fire in the launch schedule to assist in prioritizing the habitat management.

2020-04-21 - The Service sent a letter dated April 6, 2020 to the SW stating that the consultation package is complete and expects formal consultation to be concluded on July 17, 2020. The Service concurred with the may affect, but is not likely to adversely affect determination for Florida Scrub-Jay and eastern indigo snake.

2020-04-24 - The Service sent a revised concurrence letter dated April 23, 2020, correcting the project proponent name in the subject line, header, and paragraph one. No changes to the consultation conclusion date of July 17, 2020.

2020-06-10 – The Service provided SW the complete draft to review.

2020-06-25 – The Service received preliminary track tube data from the Fish and Wildlife Commission and clarified the project description with the SW on the types of management that will occur outside the area of construction.

BIOLOGICAL OPINION

1. INTRODUCTION

A biological opinion (BO) is the document that states the opinion of the U.S. Fish and Wildlife Service (Service) under the Endangered Species Act of 1973, as amended (ESA), as to whether a Federal action is likely to:

- jeopardize the continued existence of species listed as endangered or threatened; or
- result in the destruction or adverse modification of designated critical habitat.

The Federal action addressed in this BO is the refurbishment of the Launch Complex 20, for Space Florida at Cape Canaveral Air Force Station (the Action). This BO considers the effects of the Action on the southeastern beach mice (*Peromyscus polionotus niveiventris*). The Action does not affect designated critical habitat; therefore, this BO does not address critical habitat.

The 45th Space Wing (SW) has determined that the Action may affect, but is not likely to adversely affect the West Indian manatee (*Trichechus manatus latirostris*), Wood stork (*Myteria americana*), Piping plover (*Charadrius melodus*), and Red knot *(Calidris canutus*). The Service concurs with the determinations for these species in a letter dated February 10, 2020.

The Service asked for more information to support the determination for the eastern indigo snake (*Drymarchon corais couperi*) and Florida Scrub-Jay (in the concurrence letter sent on February 10, 2020. SW revised BA and the effect determination to may affect, but is not likely to adversely affect the Florida Scrub-Jay and eastern indigo snake on March 05, 2020, and the Service concurred in a letter dated April 06, 2020. The Service sent a revised concurrence letter dated April 23, 2020.

The SW has determined that the Action may affect, and is likely to adversely affect nesting marine turtles: leatherback (*Dermocheuls coriacea*), green (*Chelona mydas*), loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*), and hawksbill (*Eretmochelys imbricata*). The Service has analyzed programmatically the effects of facility lighting adjacent to nesting marine turtle habitat and has exempted incidental take under the BO, FWS Log. 2009-F-0087. The applicant and the SW have agreed to implement the measures outlined in the opinion and the Service has determined programmatically that such actions that implement all the terms and conditions of the BO will not jeopardize the continued existence of nesting marine turtles.

This BO uses hierarchical numeric section headings. Primary (level-1) sections are labeled sequentially with a single digit (e.g., 1. PROPOSED ACTION). Secondary (level-2) sections within each primary section are labeled with two digits (e.g., 1.1. Action Area), and so on for level-3 sections.

BO Analytical Framework

A BO that concludes a proposed Federal action is *not* likely to *jeopardize the continued existence* of listed species and is *not* likely to result in the *destruction or adverse modification* of critical habitat fulfills the Federal agency's responsibilities under §7(a)(2) of the ESA.

> *"Jeopardize the continued existence* means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02).
> "*Destruction or adverse modification* means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR §402.02).

The Service determines in a BO whether we expect an action to satisfy these definitions using the best available relevant data in the following analytical framework (see 50 CFR §402.02 for the regulatory definitions of *action, action area, environmental baseline, effects of the action*, and *cumulative effects*).

a. *Proposed Action*. Review the proposed Federal action and describe the environmental changes its implementation would cause, which defines the action area.

b. *Status*. Review and describe the current range-wide status of the species or critical habitat.

c. *Environmental Baseline*. Describe the condition of the species or critical habitat in the action area, without the consequences to the listed species caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early consultation, and the impacts of State or private actions which are contemporaneous with the consultation.

d. *Effects of the Action*. Predict all consequences to species or critical habitat caused by the proposed action, including the consequences of other activities caused by the proposed action, which are reasonably certain to occur. Activities caused by the proposed action would not occur but for the proposed action. Effects of the action may occur later in time and may include consequences that occur outside the action area.

e. *Cumulative Effects*. Predict all consequences to listed species or critical habitat caused by future non-Federal activities that are reasonably certain to occur within the action area.

f. *Conclusion*. Add the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, formulate the Service's opinion as to whether the action is likely to jeopardize species or adversely modify critical habitat.

2. PROPOSED ACTION

The Proposed Action is the repurposing and operation of a commercial launch site at Space Launch Complex 20 (SLC-20) at CCAFS, Florida. Space Florida intends to refurbish, enhance, and use the existing SLC-20 support shop, Horizontal Integration Facility (HIF), and blockhouse. The proposed real property license area, 220-acres, includes SLC-20 facility area that will be rehabilitated and adjacent undeveloped lands.

The facility would contain infrastructure to test rocket engines, integrate launch vehicles, and conduct launches of liquid fueled, small and medium-lift class launch vehicles. The action includes construction of a Concept A and Concept B launch pads, horizontal integration facility, fuel storage tanks, lighting, stormwater retention ponds throughout the complex, and customer and operations support buildings.

SLC-20 is located centrally within the Air Force Station and south of Space Launch Complex 34 to the north, 19 to the south, and the Atlantic Ocean to the east within Sections 5-8, Township 23 South, Range 38 East, Brevard County, Florida (Figure 2-1). The following sections deconstruct the Action in three parts: Construction, Habitat Enhancement, and Operations.

2.1. Construction

The SLC-20 real property license area is 220 acres, but most of the area proposed for construction, 33 acres, is previously disturbed and developed in areas. The Action will reuse much of the existing impervious concrete for planned roads and structures. Construction activities, such as scraping, facility demolition, or refurbishment will be required to make the existing structures viable for launch activities.

Site development will take place over three phases of construction. The BA has a list of phases with the new construction mapped within the bounds of the Proposed Action Boundary, (pg. 4-2, 4-3). The new HIF/hazardous payload processing facility along the southwest region of the Proposed Action Boundary is the only new construction that requires clearing outside the legacy SLC-20 footprint. The new HIF will result in clearing of 0.3 acre of undisturbed live oak and saw palmetto upland habitat (Figure 2-1). Remaining areas are impervious or previously disturbed and now dominated some native and exotic plant species.

Within the area of construction there will be heavy machinery and staging areas for construction equipment. The limits within the area of construction will be cleared using heavy machinery. Cleared material will be placed in wheeled dump trucks for removal from that area. Once vegetation is removed from this area, much of the site will be graded using large, heavy tracked bulldozers. Material will either be transferred to a suitable off-site area or burned on location in accordance with SW regulations as schedule and burn conditions permit. It is anticipated that all excavated soil will remain onsite within the area of construction.

Existing roadways will be reused but may require resurfacing and potentially slight widening to support small and medium launch vehicle transporters and equipment.

2.2. Southeastern Beach Mouse Habitat Enhancement

The habitat enhancement for southeastern beach mouse (SEBM) will be done within a 9.5 acre plot (Figure 2-2).

The exact acreage and methodology will be outlined in the scope of work. Relativity Space has agreed to habitat enhancement within the same area. The SW, the Service, Relativity Space, and Space Florida will be collaborating on a scope of work for the proposed area that will focus on the following:

1. Improve the condition of the ecotone between the primary and secondary habitat, thus improving the condition of the seaward edge of the secondary habitat.

2. Provide corridors from the primary habitat into good and fair condition scrub and other landward habitats.

The scope of work may include track mechanical thinning or hand clearing of coastal scrub habitat and clearing to create corridors to landward scrub habitat. Vegetation will either be removed to a suitable off-site area or incinerated on location in accordance with SW regulations as schedule and conditions permit.

2.3. Operations

Space Florida expects up to 24 total Concept A/B launches. Seventy percent of the launches are expected to occur during daylight hours and 30 percent of the launches are expected to occur during night hours (after 10 p.m. and before 7 a.m.).

To prepare for launches, payload preparation activities would be conducted in parallel with most launch vehicle preparations. Payload activities include payload checkout, spacecraft propellant loading (if required), and payload encapsulation in the fairings. The encapsulated payload would then be transported to SLC-20.

Non-hazardous and hazardous payload processing and encapsulation would take place in the existing HIF for the Concept A launch vehicle. Following construction of the new HIF, hazardous payload processing would transition to the new facility.

SLC-20 will have maintained roads and grassed areas within the complex. The areas are expected to be maintained by mowing on a periodic basis using standard large-scale grass mowing equipment. Maintained roads outside the area of construction at the complex and the security fence will be maintained on a periodic basis. The mowing right-of-way near the fence line and roads will not exceed 30 feet.

2.4. Other Activities Caused by the Action

A BO evaluates all consequences to species or critical habitat caused by the proposed Federal action, including the consequences of other activities caused by the proposed action, that are reasonably certain to occur (see definition of "effects of the action" at 50 CFR §402.02). Additional regulations at 50 CFR §402.17(a) identify factors to consider when determining whether activities caused by the proposed action (but not part of the proposed action) are reasonably certain to occur. These factors include, but are not limited to:

(1) past experiences with activities that have resulted from actions that are similar in scope, nature, and magnitude to the proposed action;
(2) existing plans for the activity; and
(3) any remaining economic, administrative, and legal requirements necessary for the activity to go forward.

In its request for consultation, the SW did not describe, and the Service is not aware of, any additional activities caused by the Action that are not included in the previous description of the proposed Action. Therefore, this BO does not address further the topic of "other activities" caused by the Action.

2.5. Action Area

The action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR §402.02). Delineating the action area is necessary for the Federal action agency to obtain a list of species and critical habitats that may occur in that area, which necessarily precedes any subsequent analyses of the effects of the action to the species or critical habitats.

It is practical to treat the action area for a proposed Federal action as the spatial extent of its direct and indirect "modifications to the land, water, or air" (a key phrase from the definition of "action" at 50 CFR §402.02). Indirect modifications include those caused by other activities that would not occur but for the action under consultation. The action area determines any overlap with critical habitat and the physical and biological features therein that we defined as essential to the species' conservation in the designation final rule. For species, the action area establishes the bounds for an analysis of individuals' exposure to action-caused changes, but the subsequent consequences of such exposure to those individuals are not necessarily limited to the action area.

Figures 2-1 and 2-2 shows the locations of all activities that the proposed Action that would cause changes to land, water, or air caused by these activities. The action area for this BO is the SLC- 20 real property lease area boundary, 220 acres, of which 33 acres is the proposed area of construction and re-development, and the proposed 9.5 acre habitat enhancement area for SEBM near SLC-19.

2.6. Tables and Figures

Figure 2-1. Real Property Lease Boundary of SLC-20 and Proposed Action Boundary. All construction activities will occur within the Proposed Action Boundary.

Figure 2-2. The proposed SEBM habitat enhancement area outlined yellow

3. SOURCES OF CUMULATIVE EFFECTS

A BO must predict the consequences to species caused by future non-Federal activities within the action area, *i.e.,* cumulative effects. "Cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation" (50 CFR §402.02). Additional regulations at 50 CFR §402.17(a) identify factors to consider when determining whether activities are reasonably certain to occur. These factors include, but are not limited to: existing plans for the activity; and any remaining economic, administrative, and legal requirements necessary for the activity to go forward.

In its request for consultation, the SW did not describe, and the Service is not aware of, any future non-Federal activities that are reasonably certain to occur within the action area. Therefore, we anticipate no cumulative effects that we must consider in formulating our opinion for the Action.

4. STATUS OF SOUTHEASTERN BEACH MOUSE

This section summarizes best available data about the biology and current condition of the throughout its range that are relevant to formulating an opinion about the Action. Most of this text is taken directly from the draft Status Species Assessment (SSA) that is currently under peer-review.

The Service published its decision to list the SEBM as threatened species under the Act in 1989 (54 FR 20598). Critical habitat is not designated for this subspecies, and therefore will not be analyzed in this opinion.

4.1. Species Description

The SEBM is one of 16 recognized subspecies of old field mice *Peromyscus polionotus* (Hall 1981); it is one of the eight of those subspecies that are called beach mice. The SEBM is a small mouse that reaches an average length of 136 mm with an average body mass of 14.5 g (Stout 1992). Southeastern beach mice have pale, buffy coloration from the back of their head to their tail, and their underparts are white.

4.2. Life History

SEBM are generally nocturnal, semifossorial, and monogamous. The subspecies occupies foredunes (i.e., frontal, primary, and secondary), transitional (i.e., coastal grasslands and coastal strand) dunes, coastal scrub dunes. SEBM also occur in interior scrub and other landward habitats, though the extent to which these areas utilized is unclear. Below is a summary of the

various elements of the SEBM life history, including reproduction, survival and mortality, foraging, home range, burrowing behavior, and habitat.

4.2.1. Survival and Mortality

The average life span of beach mice in the wild is 9 months to one year (Bird et al. 2016, Oddy 2000, Swilling 2000), although a few individuals have been known to live longer than two years. Studies at CCAFS found the mean longevity of SEBM on across study grids was 113 days with no significant differences between sexes (Oddy 2000). Maximum longevity in this study was 596 days. Swilling and Wooten (2002) found longer persistence times associated with mice dispersing further away from their natal home range, perhaps a result of reduced predation rates.

4.2.2. Foraging

Beach mice are food generalists and feed on a variety of seeds of dune and scrub plants and insects (Moyers 1996, Sneckenberger 2001, Keserauskis 2007).

Studies show that the diet of the SEBM varies seasonally and among and within habitats, and fruits, seeds and arthropods that feed on them comprise most of their diet (Keserauskis 2007).

In most cases, fruits and seeds that are consumed by beach mice are produced by low growing, prostrate plants, on supple stems easily manipulated by mice, or as the fruits and seeds become available as fallen seeds (Moyers 1996). Beach mice also consume invertebrates, especially during late winter or early spring when seeds are scarce (Ehrhart 1978).

4.2.3. Home Range

Beach mouse home range size varies among subspecies (USFWS 2010) and may vary seasonally and in relation to density as well as habitat and food resources. Beach mouse home ranges average approximately 1.2 acres (Bird 2016). Swilling and Wooten (2002) found the mean home range for Anastasia beach mice (ABM) (both sexes) was approximately 0.89 acres, whereas using radio telemetry data, Lynn (2000) found home ranges of 1.68 acres and 1.73 acres for males and females respectively; neither study noted significant differences in home range size between males and females.

Blair (1951) found home ranges of beach mice living in the comparatively dense cover of the beach dunes averaged significantly larger in the spring than in the fall. Beach mice tend to inhabit a single home range throughout their lifetime and will often maintain several burrows within their home range (Blair 1951). Extine and Stout (1987, USFWS 1999) reported movements of the SEBM between the primary dunes and interior scrub on Kennedy Space Center (KSC) and Merritt Island National Wildlife Refuge (MINWR) and concluded that home ranges can overlap and reach high densities within preferred habitats.

4.2.4. Burrows

While multiple species of *Peromyscus* will excavate burrows, *P. polionotus* is the only member of the genus that excavates its own burrow, which is extensive (Ehrhart 1978, USFWS 1999). Beach mice are semifossorial, and may utilize as many as 20 burrows within their home range (USFWS 1999). Beach mice will use burrows as a place to rest during the day and between nightly foraging bouts. Burrows are also used for escape from predators, birthing and caring for young.

Burrows generally consist of an entrance tunnel, nest chamber, and escape tunnel (Weber et al. 2013). High predation risk and the harsh coastal environment make selection of quality burrow sites critical for survival of beach mice (Swilling and Wooten 2002). Beach mice have been found to select burrow sites based on a suite of biotic and abiotic features. (Lynn 2000; Sneckenberger 2001).

Bird et al. (2004) in a study exploring the effects of artificial illumination on the behaviors of beach mice found that patch use was affected by the presence of illumination, light type, and distance from light source. In this study, foraging frequency was significantly higher in dark arrays and that more seeds were removed from resource patches as distance from illumination increased. This is consistent with the observation that beach mice activity decreases in response to increased levels of moonlight due to elevated risk perceptions (Stoddard et al. 2018).

4.2.5. Habitat

Beach mouse habitat includes a heterogeneous mix of interconnected coastal communities on barrier islands. Holler (1992) described beach mouse habitat at the time as including primary and secondary dunes vegetated by sea oats, beach grass (*Panicum amarum*), and blue stem (*Andropogon maritimus*). Contemporary understandings of the geographic distribution of beach mouse habitat is that beach mice inhabit coastal dune, strand, and scrub habitats (where available) that range from being comprised mostly of grasses to mostly shrubs (Sneckenberger 2001, Suazo et al. 2009, Stout et al 2012, Wilkinson et al. 2012, Breininger et al. 2018). Additionally, the coastal strand and scrub plant communities (e.g. Cape Canaveral area) likely serve as refugia for and sources of individuals that disperse into dune systems after storm events (Stout et al. 2012).

Coastal communities of Florida can be classified into three general zones. These zones, as described by Johnson and Barbour (1990) and used in the draft Species Status Assessment include ***foredunes*** (frontal, primary, and secondary), ***transitional dunes*** (coastal grasslands and strands), and ***coastal scrub dunes***. Additionally, beach mice are known to utilize adjacent or connected landward habitats including ***interior scrub*** (particularly within the Cape Canaveral), ruderal or old-field environments, and mowed roadside edges and rights-of-way.

Foredunes occur in the zone nearest the shoreline, but beyond the limits of the forces of annual wave action (Johnson and Barbour 1990) and include dunes frequently referred to as frontal, primary, and secondary. There is considerable uncertainty regarding optimal ranges of habitat conditions for SEBM in foredune areas. Given the differences in beach mouse habitats between

the Gulf and Atlantic coasts, additional research is needed to accurately define optimal habitat conditions within foredune areas specific to SEBM.

Transitional dunes are in the zone situated between the foredunes and more distinct natural communities such as coastal scrub or maritime hammock (FNAI 2010). Transitional dunes may include herbaceous natural communities such as coastal grasslands as well as areas with a higher prevalence of woody plants such as coastal strand.

Coastal scrub dunes are typically located behind the foredunes. In addition to the shrubbier form of live oak, plant assemblages in this community include myrtle oak (*Q. myrtifolia*), saw palmetto, and yaupon holly (*Ilex vomitoria) (*Kurz 1942, Johnson and Barbour 1990) within a matrix of open sand areas. The low stature of coastal scrub is maintained via the effects of salt spray to terminal buds of plants (Johnson and Barbour 1990). Similarly, to inland scrub habitats (described below), periodic fires are integral to the maintenance of coastal scrub systems. In the absence of fire or in combination with fire, mechanical treatments may be used to manipulate the structure of vegetation within scrub communities.

While the predominance of SEBM occurrence within scrub type habitats is in the coastal scrub dunes, SEBM are known to occur in more interior scrub environments within the Cape Canaveral Complex. The cape feature at Cape Canaveral is unique among SEBM habitats as it includes a broad expanse of upland habitats between the Atlantic coast and the Banana and Indian Rivers. Beyond the Cape Canaveral, SEBM habitat generally occurs in narrow stretches along the shoreline.

While seasonally abundant, the availability of food resources in the foredunes fluctuates (Sneckenberger 2001). In contrast, the scrub habitat provides a more stable level of food resources, which becomes crucial when food is scarce or nonexistent in the primary and secondary dunes. Furthermore, the coastal scrub dunes appear to serve as refugia for beach mice during and after tropical storm events (Holliman 1983, Swilling et al. 1998), from which recolonization of the foredunes takes place (Swilling et al. 1998, Sneckenberger 2001). This suggests that access to primary, secondary, and coastal scrub habitat is essential to beach mice at the individual and population levels and to some extent at the range wide level. Additionally, studies have found no detectable differences between scrub and frontal dunes in beach mouse body mass, home range size, dispersal, reproduction, survival, food quality, and burrow site availability (Swilling et al. 1998, Swilling 2000, Sneckenberger 2001). It should be noted that the presence of "scrub" habitat with or without storm events as a driving factor for SEBM is known only for the Cape Canaveral area and portions of the panhandle; the entire dune system of the CNS and other areas of SEBM habitat mostly lack this feature.

Beyond the foredunes, transitional areas and coastal scrub, barrier islands often grade into stabilized dunes where shrubby plant communities give way to canopied forests. Stable dune areas may include maritime hammocks and forests that are not considered suitable beach mouse habitat. SEBM rarely, if ever, occur in areas where woody vegetation >2m is dominant (Stout 1992). Additionally, while Toombs' (2001) captured SEBM in the primary dunes and none were captured in dense areas of saw palmetto where it may be more difficult to burrow, this does not

appear to be representative of occupancy of SEBM within the Cape Canaveral Complex in more dense and unmanaged coastal habitats (Oddy personal communication, 2019). There is research that provides evidence of long-term occupancy of interior scrub habitats by SEBM within the CCAFS (Stout 1979, Suazo et al. 2009, Simmons 2008).

The three general zones can be classified into two habitat classes for SEMB. **Primary habitat** identifies the characteristic dune habitats typically occupied by SEBM (foredunes, transitional dunes, and coastal scrub dunes). **Secondary habitats** include interior scrub and other natural and human-altered landscapes landward of the dunes that provide critical refugia habitat and may support SEBM resource needs, may provide movement corridors, or may support an extension of a population.

4.3. Numbers, Reproduction, and Distribution

4.3.1. Numbers and Distribution

SEBM are found in coastal habitats of Florida's east coast. The 1989 Final Listing Rule states that the subspecies was known to occur on Canaveral National Seashore (CNS), MINWR, CCAFS, the north and south ends of Orchid Island at Sebastian Inlet area and Fort Pierce Inlet State Park (also known as north Hutchinson Island) on the north side of Ft. Pierce Inlet.

The Recovery Plan for the Anastasia Island Beach Mouse and the Southeastern Beach Mouse (USFWS 1993) described the limits of occurrence of SEBM from Volusia County at Canaveral National Seashore south to 7 miles north of the Brevard County line and including scattered localities in Indian River County, and St. Lucie County. At the time of listing, in areas south of St. Lucie Inlet, nearly all dune habitat was developed and unsuitable for beach mice (USFWS 1988). Some potentially suitable habitat remains within public conservation lands on Jupiter Island, St. Lucie Inlet Preserve State Park, Hobe Sound National Wildlife Refuge and in Palm Beach County at John D. MacArthur Beach State Park.

In the draft SSA, the Service reviewed the extant and historic distribution of the species range wide and grouped the populations into geographic segments: Canaveral North, Canaveral South, Orchid Island/ Hutchinson Island North, Hutchinson Island, Jupiter Island, Jupiter South, Palm Beach, Boynton, and Hillsboro. The geographic segments are illustrated in Figure 4-1. and includes inlet locations associated with limits of historic range (light grey box), limits of range at the time of federal listing (1989; medium grey box), current range where two extant populations are known to occur (dark grey box), and areas of uncertain occupancy (red dashed lines).

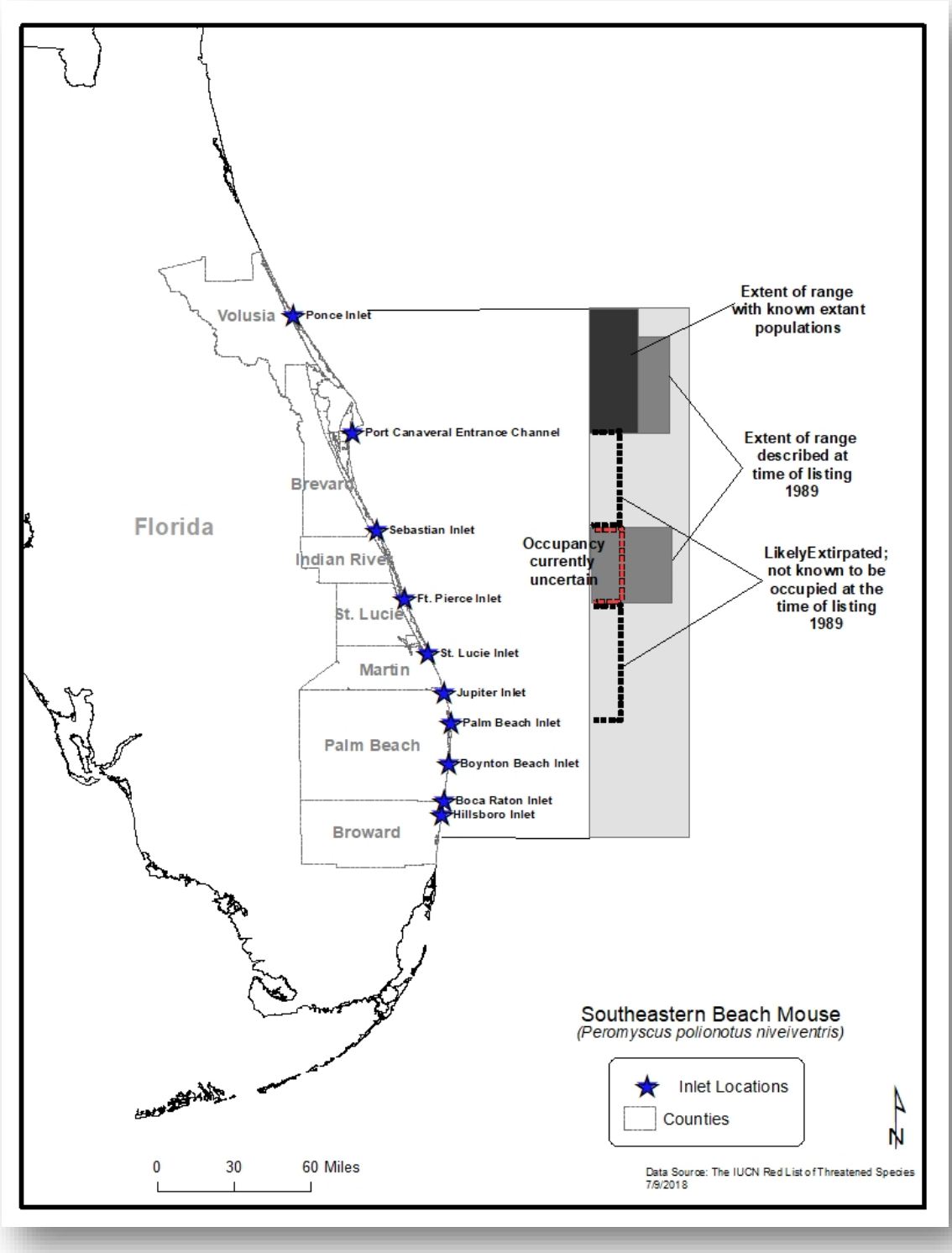

FIGURE 4.1 SEBM RANGE MAP – Extant and Likely Extirpated.

To assess current condition of the species, the draft SSA characterizes the amount of primary and secondary habitat within the geographic segments across the range of species. The geographic segments are parsed in eight different resilience units. The Canaveral Complex resilience unit is the most important for the recovery of the species.

The Canaveral Complex Unit is a metapopulation and has the most habitat to support the species. The Canaveral Complex has 89% of the total protected habitat, with the most acres of primary habitat, 3,377 acres, and 11,897 secondary habitats. Within the secondary habitat, the natural communities within occur at a fine-scale mosaic of conditions that may or may not be suitable for SEBM.

4.3.2. Reproduction

Beach mice have a monogamous mating system (Blair, 1951, Smith 1966, Lynn 2000). Mated pairs tend to remain associated in acquiring food and sharing burrows (Blair 1951). Beach mice reach sexual maturity at 55 days of age; however, some mice are capable of breeding earlier (Ehrhart 1978).

Peak breeding season for beach mice appears to occur between November and early January (Blair 1951) and appears to coincide with increased availability of food from the previous growing season (Rave and Holler 1992); although pregnant and lactating SEBM have been observed in all seasons (Stout 1979, Oddy et al. 1999, Oddy 2000, Bard personal communication, 2019).

While the reproductive potential of beach mice is generally high, Blair (1951) reported only 19.5 percent of beach mice within his study survived from January to May in the same year indicating that mortality of adult beach mice is also quite high.

4.4. Conservation Needs and Threats

4.4.1. Conservation Needs

There is considerable uncertainty regarding beach mouse use of the scrub and more stable, interior habitats, particularly within the CCAFS. Future research is needed to better define optimal habitat conditions for SEBM in coastal scrub and interior scrub habitats. Habitat conditions within the interior scrub areas that benefit the threatened Florida Scrub-jay (*Aphelocoma coerulescens*) may also benefit SEBM (Suazo et al. 2009). While ranges of habitat conditions occur as a result of management regimes and techniques, optimal habitat conditions for Florida Scrub-Jays within the interior scrub within the Canaveral Complex includes a more open habitat structure (Breininger 1992, Breininger et al. 2003, USFWS 2007) that is ideally maintained with use of periodic prescribed fire. Optimal fire-return intervals may be shorter in coastal scrub habitats than in more interior locations (Schmalzer and Hinkle 1992), which may result in less desirable SEBM conditions in the more interior areas. Depending on the matrix of vegetation within the coastal scrub and adjacent habitats, fire return frequencies vary from 3 to

10 years (USFWS 2007). In the absence of fire, the cover and stature of woody vegetation increases, often resulting in the loss of open areas.

4.4.2. Threats

Habitat loss and fragmentation due to destruction associated with residential and commercial development has created disjunct and isolated populations of SEBM along the east coast of Florida. South of the Port Canaveral Entrance Chanel, five inlets between Indian River and Broward Counties create additional barriers to dispersal. Most remaining SEBM habitat occurs on public conservation lands, though some private lands also support areas of natural dune vegetation that could be occupied by beach mice (e.g. St. Lucie Nuclear Power Plant, undeveloped lots, and undeveloped portions of residential and commercial lots). As a result, extant populations of SEBM are geographically and thus genetically, isolated. Within the current landscape configuration, natural dispersal between existing populations is highly unlikely.

Other threats to the species include shoreline armoring to protect coastal to protect coastal properties from erosion, coastal lighting at facilities or residential development, vehicular or foot traffic near developments, and climate change.

5. ENVIRONMENTAL BASELINE FOR SOUTHEASTERN BEACH MICE

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the southeastern beach mice its habitat, and ecosystem within the action area. The environmental baseline is a "snapshot" of the species' health in the action area at the time of the consultation and does not include the effects of the Action under review.

5.1. Action Area Numbers, Reproduction, and Distribution

The SEBM is found along the entire reach of immediate coastline and within coastal strand on CCAFS in addition to the KSC and Cape Canaveral National Seashore. The known distribution is a result of cursory surveys, intermittent trapping involving different construction projects, two demography studies conducted in 2007, 2011-2012, and annual occupancy studies conducted 2010-2015, and 2018. In addition, several captures of have occurred in the existing blockhouse in 2001.

In 2020, Florida Fish and Wildlife Conservation Commission (FWC), set up tube tracking cameras to monitor SEBM use near the SLC pads that are proposed for rehabilitation or construction and the near the pad proposed for the habitat enhancement. Track tubes at SLC 16 and 19 have been deployed since late January 2020 and have been checked a total of 9 times. Track tubes at SLC 20 have been in place since late April 2020 and have been checked 3 times. Track tubes at LMU 18 and 22 have been out since late April and have been checked 4 times. All track tubes are checked every 2 weeks. Figure 5-1, is a map of the preliminary data sent to the Service on June 25, 2020, and the map has the detection rates displayed as percentage of total surveys at a site with positive beach mouse detections.

Using the GIS layer created for the draft SSA, we reviewed distribution the primary and secondary habitat within the real property lease area (Figure 5.2). The lease area is 220 acres with 25 acres of primary habitat (landward foredunes), and 90 acres secondary habitat (human altered habitat of the dune). The area of construction within the lease area has about 4 acres of primary habitat and 5 acres of secondary habitat.

To estimate the number of individuals that the lease area may support, we reviewed home range data and compared it to the acres of primary habitat within the action area. Beach mouse home ranges average approximately 1.2 acres (Bird 2016), .89 acres for both male and female (Swilling and Wooten 2000), and 1.68 acres and 1.73 acres for males and females respectively (Lynn 2000). Using the 25 acres of primary habitat, we estimate the lease area has enough primary habitat to support between 15 – 28 individuals. However, the habitat within the action area has not been managed to support the species, and the transitional dune systems is degraded from previous development. The maintained grasses in the lease area portion of the action area have a mixture of native and exotic species, making the foraging habitat less than ideal. Based on the habitat condition there is likely a small fraction of the estimated individuals within the lease area portion of the action area. We expect a smaller number of those individuals are utilizing the primary (4 ac) and secondary habitat (5 ac) within the proposed construction area (33 ac) for foraging, burrows, and travel corridors.

5.2. Action Area Conservation Needs

The proposed construction area for SLC-20 is situated west of the beach dune area. Figure 5-1 shows the habitat types within the construction portion of the action area and the entire lease portion of the action area.

To support SEBM, the coastal scrub and grasses should be managed, particularly areas that connect to the seaward edge of the secondary habitat. Restoration and management of the primary and secondary habitat may provide increased connectivity, allow for storm refugia, and diverse forage.

SEBM are at increased risk to predation and modify their foraging behavior when exposed to artificial lighting. Lighting should be managed to protect coastal species, including SEBM which are vulnerable to excessive coastal lighting.

5.3. Tables and Figures

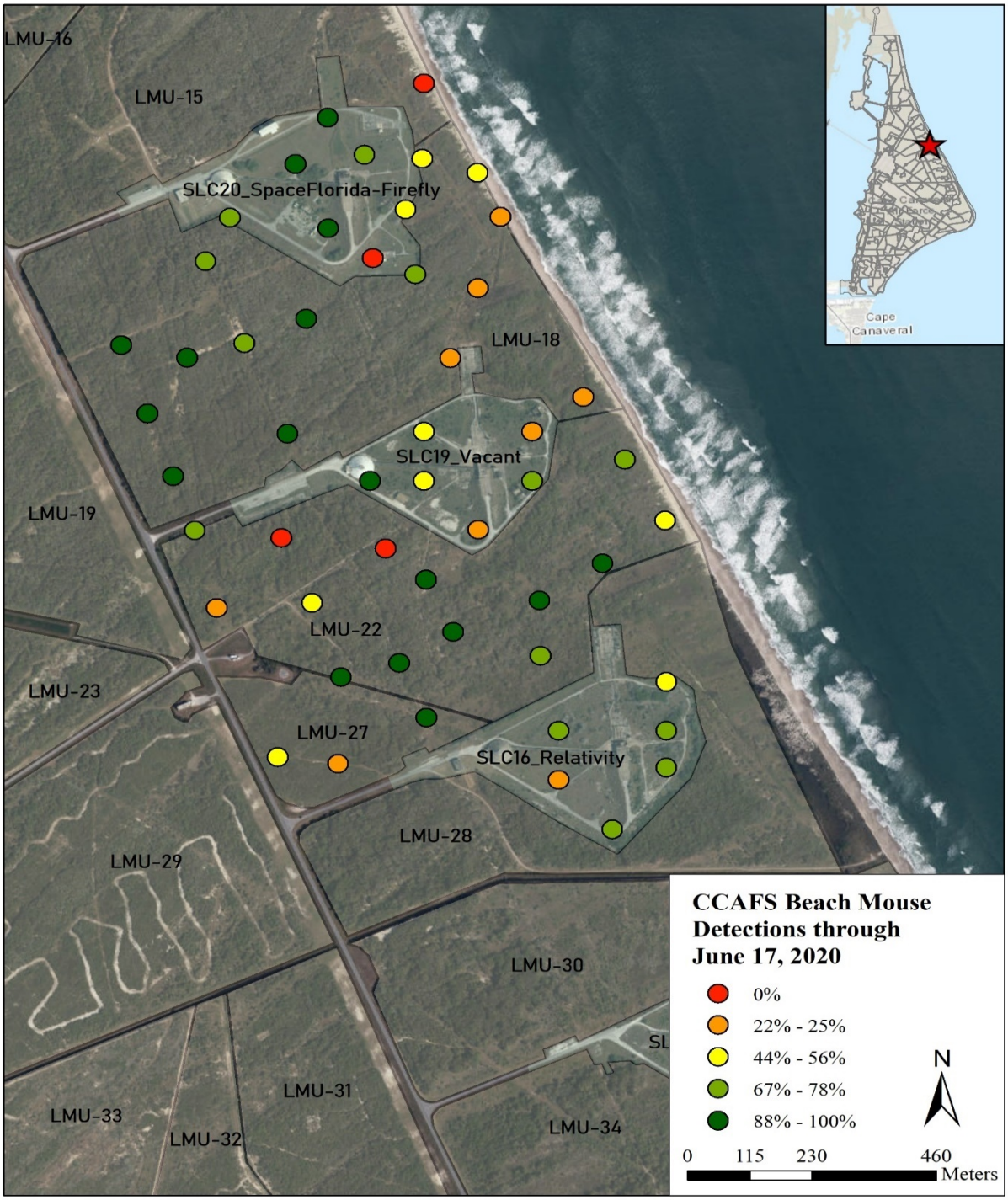

Figure 5-1. CCAFS Track Tube SEBM Detections through June 17, 2020. Preliminary data provided by FWC.

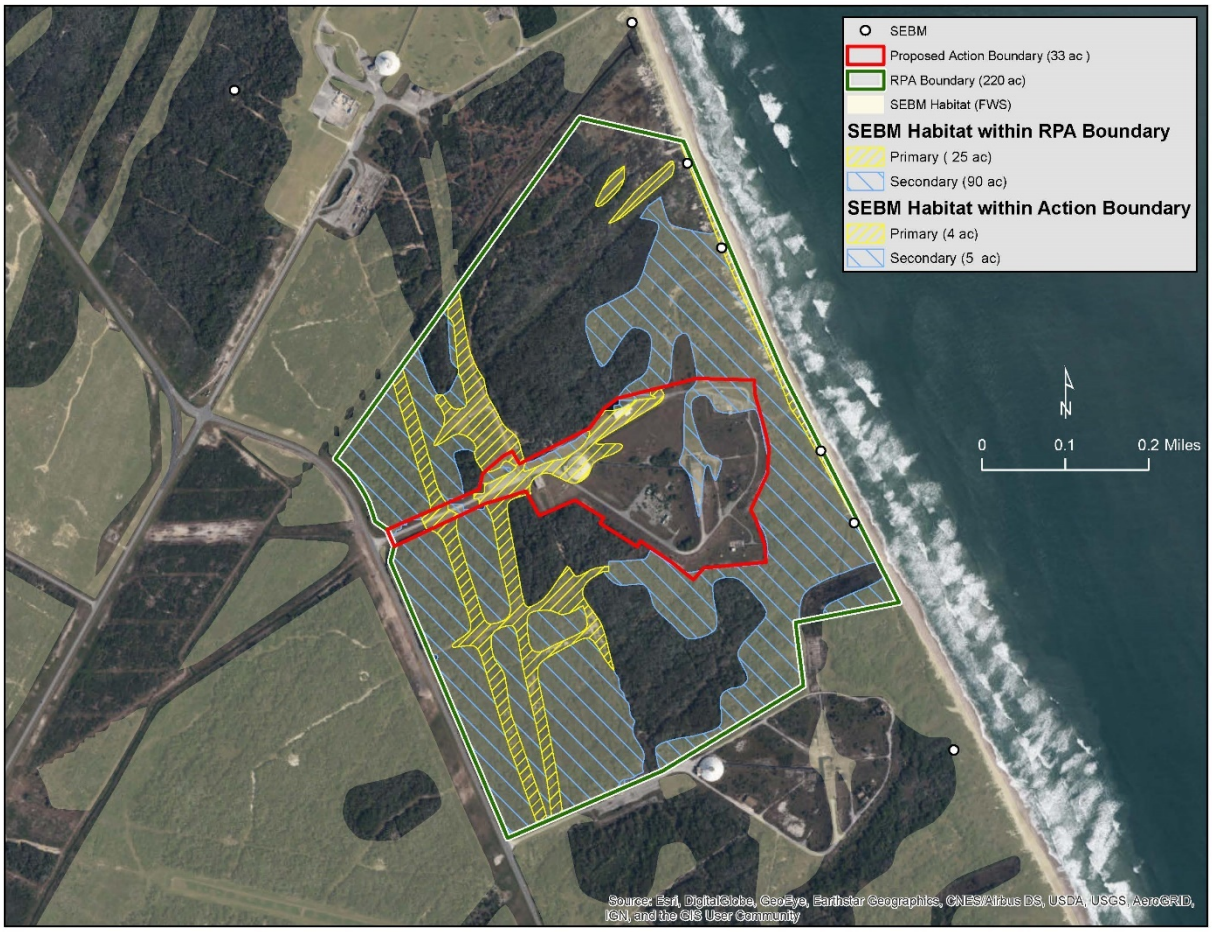

Figure 5-2. Habitat types (primary and secondary) within the Real Property Lease Area of SLC- 20.

6. EFFECTS OF THE ACTION ON SOUTHEASTERN BEACH MICE

In a BO for a listed species, the effects of the proposed action are all reasonably certain consequences to the species caused by the action, including the consequences of other activities caused by the action. Activities caused by the action would not occur but for the action. Consequences to species may occur later in time and may occur outside the action area.

We identified and described the activities included in the proposed Action in sections 2.1–2.3. Our analyses of the consequences caused by each of these activities follows.

6.1. Facility Construction and Refurbishment

Construction activities will include heavy equipment to remove live oak and saw palmetto in inland areas and refurbishment of the launch complex. The refurbishment will consist of heavy equipment for the demolition and new construction of a customer support building, operation support building, and development of generators at the historical site near facility 18800 and the Blockhouse. The habitat is degraded but has habitat for SEMB. The species has been recorded in

the Blockhouse and recorded via track tubes this year. Preliminary data indicates that the species is utilizing the area, however density cannot be derived from these data. There will be several facilities constructed within the existing launch pad, including a non-hazardous payload processing facility and Concept A within SEBM habitat. The consequences of the action, construction activities and modifying areas where the species is known to be present, will result in the loss of habitat that supports resource needs such as foraging and a movement corridor.

Based on plans for construction, the Service expects harm to any individuals via the destruction of burrows during clearing activity or during the refurbishment of facilities or new construction in primary habitat, secondary habitat or possibly in the construction area of the launch facility. Individuals may also be harmed if they are utilizing the primary or secondary habitat for burrows or within the construction area. Using action area baseline estimates outlined in section 5.1, we expect several SEBM and/or nestlings will be exposed to the consequences of habitat destruction and new construction associated with re-development of the launch facility. There is also some risk that construction activities within the 33 acres of the project area may adversely affect the SEBM that may be using the area as a movement corridor or foraging area.

Preliminary track tube data (Figure 5-1) indicates that during the period tubes were monitored, that SEBM are frequently utilizing the area for foraging. Track tube detections were outside the primary and secondary habitat within the pad area. However, most, if not all, of the construction will occur within the daytime periods when mice are typically inside burrowing habitat and not out moving within the habitat. Most of the soils within the construction area are compacted from past use and development, but some of the soils could still support burrows. Construction activities could collapse undetected burrows within the 33 acres of the construction area, and we anticipate there is a risk that SEBM may not be able to excavate or escape from a collapsed burrow.

The scale of the action area is a small fraction of the geographic segment of the Canaveral Complex Unit. The loss of a several individuals will not result is adverse population effects or reduce appreciably the species' likelihood of survival and recovery. Additionally, the refurbishment of the launch facility will not place barriers for species movement, a threat to the species described in section 4.4. After construction activities, we expect the species will have access and can use the primary and secondary habitat within the lease area as a corridor for movement, refugia, or forage opportunities.

To set a standard for determining when the level of anticipated take has been exceeded, the Service can establish a causal link to construction activities within primary and secondary habitats, see Figure 5.1 showing habitat types within the construction area, to the harm or "taking" of the species. The linking habitat within the construction boundary of the action area will allow the Service to have a clear standard for determining when the level of anticipated take has been exceeded.

6.2. Southeastern Beach Mouse Habitat Enhancement

The purpose of the SEBM habitat enhancement plan is to address the conservation needs of the species within the action area. The habitat enhancement plan and monitoring shall be developed with the Service, FWC, and SW with support of Space Florida. The plan will include an FWC monitoring component to monitor how the species is using the coastal scrub habitat between the space launch facilities.

The removal dense woody vegetation and coastal scrub management will allow for species movement and increase forage quality in the secondary habitat. If project timing allows, the Service is recommending that the habitat enhancement area serve as a recipient site for mice found within the construction area (described in Section 8, Conservation Recommendations). The recommendation includes saturation trapping of SEBM in areas that are slated for construction, roadways or anywhere habitat modification shall occur. To minimize adverse effects to the species, saturation trapping should be completed by a qualified biologist and follow the 2020 Beach Mouse Protocol for trapping, thus reducing the likelihood that the species is harmed via trapping or relocating activities. Because we anticipate that individuals would be harmed during construction, the salvaging of all individuals via trapping and moving the newly restored area would be a net benefit to the species.

If salvage activities cannot occur due to project timelines or the timeline of the habitat restoration component, the restoration and enhancement of coastal scrub will still provide a net benefit to the species and addresses the conservation needs of the species range-wide and within the action area.

6.3. Operations

SEBM have been documented inside facilities throughout CCAFS, the SW has a Programmatic BO that covers pest management activities within and around such facilities. Per the Programmatic BO, Space Florida will be required to live trap and release mice within and around its facilities on SLC-20.

During facility operations, rocket launches may startle SEBM, and noise associated with landing, though not as loud, may do the same. Noise impact to wildlife is expected to be minimal and discountable. Current and past launch programs at CCAFS, the Atlas, Titan, and Delta launches did not document any animal mortality associated with noise.

Operational lighting at the facility may have adverse effects to the species by disrupting foraging behavior. Nighttime launches and the lighting needed to support these events will have some adverse effects, but it is anticipated not to last more than a few days to support the launch activity. We expect that the lighting will be managed to standards outlined in the Programmatic Sea Turtle Biological Opinion, 2009-F-0087, and conform to the SW Instruction 32-7001. This will minimize lighting and restrict lighting visible to the beaches during sea turtle nesting season (1 May through 31 October). Beach mice will likely benefit from these restrictions, but the period does not cover the wintertime, a peak period for SEBM.

SLC-20 will have maintained roads and grassed areas within the complex. The maintained roads and grass areas within the complex are expected to be maintained by mowing on a periodic basis using standard large-scale grass mowing equipment. Mowing or habitat modification within the real property lease area is not proposed except for the 30 feet right-of-way around the perimeter of the fence line and adjacent to the roads that lead to the launch complex. The Service expects minimal disturbance to the species via noise, vibration, and temporal loss of forage associated with periodic maintenance.

7. CONCLUSION

"*Jeopardize the continued existence*" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02). After reviewing the current status of the species, the environmental baseline for the Action Area, the effects of the Action and the cumulative effects, it is the Service's BO that the Action is not likely to jeopardize the continued existence of the southeastern beach mouse.

The Service has come to this conclusion based on the following:

- The loss of several individuals within the action area will not result in adverse population effects or reduce appreciably the species' likelihood of survival and recovery.
- The refurbishment of the launch facility will not place a barrier for species movement that will preclude or delay recovery goals.
- After construction activities, we expect the species will access and use the primary and secondary habitat within the lease area as a corridor for movement, refugia, or forage opportunities.
- Restoration of coastal scrub at SLC-19 addresses conservation needs of the species within the action area and recovery needs for the species range-wide.

8. INCIDENTAL TAKE STATEMENT

ESA §9(a)(1) and regulations issued under §4(d) prohibit the take of endangered and threatened fish and wildlife species without a special exemption. The term "take" in the ESA means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (ESA §3(19)). In regulations, the Service further defines:

- "harm" as "an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering;" (50 CFR §17.3) and
- "incidental take" as "takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant" (50 CFR §402.02).

Under the terms of ESA §7(b)(4) and §7(o)(2), taking that is incidental to a Federal agency action that would not violate ESA §7(a)(2) is not considered prohibited, provided that such taking is in compliance with the terms and conditions of an incidental take statement (ITS).

The Action considered in this BO includes the refurbishment of the SLC-20, Space Florida Launch Complex at Cape Canaveral and the SEBM habitat enhancement area. This BO considers the effects of the Action on southeastern beach mice (*Peromyscus polionotus niveiventris*). The Action does not affect designated critical habitat; therefore, this BO does not address critical habitat.

For the exemption in ESA §7(o)(2) to apply to the Action considered in this BO, the SW and the Space Florida must undertake the non-discretionary measures described in this ITS, and these measures must become binding conditions of any permit, contract, or grant issued for implementing the Action. Consistent with ESA section 7(b)(4)(C)(iv), the SW has a continuing duty to regulate the Action activities covered by this ITS that are under its jurisdiction. The Space Florida is responsible for the Action activities covered by this ITS that are under its control and are not under SW jurisdiction. The protective coverage of §7(o)(2) may lapse if the SW or Space Florida fails to:

- assume and implement the terms and conditions; or
- require a permittee, contractor, or grantee to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit, contract, or grant document.

In order to monitor the impact of incidental take, the SW and Space Florida must report the progress of the Action and its impact on the species to the Service as specified in this ITS.

8.1. Amount or Extent of Take

This section specifies the amount or extent of take of listed wildlife species that the Action is reasonably certain to cause, which we estimated in the "Effects of the Action" section of this BO. Table 8-1 identifies the species, life stage(s), estimated number of individuals, the form of take anticipated, and the section of the BO that contains the supporting analysis.

Table 8-1. Estimates of the amount of take (# of individuals) caused by the Action, by species, life stage, and form of take, collated from the cited BO effects analyses.

Common Name	Life Stage	# of Individuals	Form of Take	BO Effects Analysis Section
Southeastern Beach Mice	ALL	Several	Harm	6.1
Southeastern Beach Mice	Adult or Juvenile	ALL*	Capture	6.2

* Capture is exempted if the Conservation Recommendations are undertaken by the SW, SW authorized agents, FWS personnel or SEBM recovery permit holders. Salvage activities via capture of SEBM within the action area under this BO must follow the Service's South Eastern Beach Mouse Trapping Protocols 2020 or most recent version. Please contact the Service for these protocols.

It is difficult to estimate number of species within the action area, section 5.1 estimates use home ranges, but the actual number of individuals is likely a fraction of this estimate because the habitat quality. Additionally, salvage success will likely to be less within the areas where the construction actions are slated to occur.

Surrogate Measures for Monitoring

For the SEBM, detecting take that occurs incidental to the Action is not practical. SEBM are semi-fossorial during the day so locating all individuals within the area slated for construction is impractical. However, we do know that 4 acres of primary habitat and 5 acres of secondary habitat is within the 33 acres of construction area. The Service will monitor take using the temporary modification of the habitat as the surrogate.

When it is not practical to monitor take in terms of individuals of the listed species, the regulations at 50 CFR §402.14(i)(1)(i) indicate that an ITS may express the amount or extent of take using a surrogate (*e.g.,* a similarly affected species, habitat, or ecological conditions), provided that the Service also:

- describes the causal link between the surrogate and take of the listed species; and
- sets a clear standard for determining when the level of anticipated take has been exceeded.

We have identified surrogate measures in our analyses of effects that satisfy these criteria for monitoring take of the species named above during Action implementation. Table 8-2 lists the species, life stage, surrogate measure, and the section of the BO that explains the causal link between the surrogate and the anticipated taking. We describe procedures for this monitoring in section 8.4.

Table 8-2. Surrogate measures for monitoring take of listed wildlife species caused by the Action, based on the cited BO effects analyses.

Common Name	Life Stage	Surrogate (units)	Quantity	BO Effects Analysis Section
Southeastern Beach Mice	All	Primary/secondary habitat acres within the proposed construction limits	9	6.1

8.2. Reasonable and Prudent Measures

The Service believes that no reasonable and prudent measures are necessary or appropriate to minimize the impact, *i.e.,* the amount or extent, of incidental take of southeastern beach mice caused by the Action. Minor changes that do not alter the basic design, location, scope, duration, or timing of the Action would not reduce incidental take below the amount or extent anticipated for the Action as proposed. Therefore, this ITS does not provide RPMs for these species.

8.3. Terms and Conditions

No reasonable and prudent measures to minimize the impacts of incidental take caused by the Action are provided in this ITS; therefore, no terms and conditions for carrying out such measures are necessary.

8.4. Monitoring and Reporting Requirements

In order to monitor the impacts of incidental take, the SW must report the progress of the Action and its impact on the species to the Service as specified in the incidental take statement (50 CFR §402.14(i)(3)). This section provides the specific instructions for such monitoring and reporting. As necessary and appropriate to fulfill this responsibility, the SW must require any permittee, contractor, or grantee to accomplish the monitoring and reporting through enforceable terms that are added to the permit, contract, or grant document. Such enforceable terms must include a requirement to immediately notify the SW and the Service if the amount or extent of incidental take specified in this ITS is exceeded during Action implementation.

M&R 1. Reporting After construction is completed, report to the Service the sum (in acres) that was modified or cleared within the area of construction. The sum shall not exceed 33 acres which includes 4 acres of Primary habitat within the area of construction.

M&R 2. Disposition of Dead or Injured Upon locating a dead, injured, or sick threatened or endangered species, notification must be made to the North Florida Ecological Services Field Office at 904-731-3336 and by email to Jaxregs@FWS.gov within 24 hours. If an injured or sick specimen is found and North Florida Ecological Services Field Office staff is unable to be reached, contact the Florida Fish and Wildlife Conservation Commission Wildlife Alert Hotline at 1-888-404-3922.

Care should be taken in handling dead specimens to ensure biological material is preserved in the best possible state for later analysis as to the cause of death. If a dead specimen is found in the project area, the specimen should be thoroughly soaked in water and frozen for later analysis of cause of death. In conjunction with the preservation of biological materials from a dead animal, the finder has the responsibility to carry out instructions provided by Law Enforcement to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

9. CONSERVATION RECOMMENDATIONS

§7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by conducting conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary activities that an action agency may undertake to avoid or minimize the adverse effects of a proposed action, implement recovery plans, or develop information that is useful for the conservation of listed species.

1. Salvage any SEBM that would otherwise be harmed by the action.
   If project timing allows, complete the habitat enhancement before the construction activities at SLC-20. The habitat enhancement area could serve as a recipient site for SEBM residing within the construction area of the launch complex. Saturation trapping of SEBM (conducted by a qualified biologist) should be completed within the area of construction before construction activities commence. Mice found within the area of construction may be relocated to the habitat enhancement areas between SLC-16 and SLC-19. If the habitat enhancement area/restoration activities are not completed, SEBM may be moved to nearby low to non-occupied suitable habitat.
2. Collaborate with FWC to monitor SEBM within the habitat enhancement area between SLC-16 and SLC-19 and other areas of interest at Cape Canaveral Complex.

10. REINITIATION NOTICE

Formal consultation for the Action considered in this BO is concluded. Reinitiating consultation is required if the SW retains discretionary involvement or control over the Action (or is authorized by law) when:

a. the amount or extent of incidental take is exceeded;
b. new information reveals that the Action may affect listed species or designated critical habitat in a manner or to an extent not considered in this BO;
c. the Action is modified in a manner that causes effects to listed species or designated critical habitat not considered in this BO; or
d. a new species is listed or critical habitat designated that the Action may affect.

In instances where the amount or extent of incidental take is exceeded, SW is required to immediately request a reinitiation of formal consultation.

11. LITERATURE CITED

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APPENDIX D

Biological Assessment

BIOLOGICAL ASSESSMENT FOR THE RECONSTITUTION AND ENHANCEMENT OF SPACE LAUNCH COMPLEX 20 MULTI-USER LAUNCH OPERATIONS AT CAPE CANAVERAL AIR FORCE STATION, FLORIDA

REVISION A

Prepared for:

SPACE FLORIDA

Space Florida

In Cooperation With:

45TH SPACE WING

45th Space Wing, Patrick Air Force Base, Florida

Prepared by:

Jones Edmunds, BRPH, and LG2 Environmental Solutions Inc.

Jones Edmunds Project No.: 02655-008-01

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1 SUMMARY

Space Florida was created pursuant to Chapter 331, Part II, Florida Statutes as an independent special district and subdivision of the State of Florida. The purpose of Space Florida is to foster the growth and development of a sustainable and world-leading aerospace industry in Florida. Space Florida leverages Florida's highly skilled workforce and existing infrastructure to attract and expand the next generation of space industry businesses. The Cape Canaveral Spaceport (CCS), where Space Florida has an operational spaceport authority role, is the premiere transportation hub for global space commerce. Space Florida oversees management and operation of key elements of Florida's existing space transportation capability.

Space Florida is pursuing a Real Property Agreement (RPA) with the US Air Force (USAF) 45th Space Wing of approximately 220 acres (88 hectares [ha]) of land, to include Space Launch Complex 20 (SLC-20) and all facilities contained within, at Cape Canaveral Air Force Station (CCAFS). Space Florida will develop and sublicense the approximately 220 acres to meet current and future commercial, national, and state space transportation requirements through the expansion and modernization of space transportation facilities.

Space Florida, in cooperation with USAF as the Lead Agency, and the Federal Aviation Administration (FAA) and National Aeronautics and Space Administration (NASA) as Cooperating Agencies, is preparing an Environmental Assessment (EA) to comply with National Environmental Policy Act (NEPA) requirements to support obtaining the Real Property transfer. This EA will evaluate the potential environmental impacts resulting from the refurbishment and enhancement of SLC-20 facilities, operation of small- and medium-lift launch vehicles on 33 acres (13.2 ha) of the 220 acres, activities associated with redeveloping SLC-20 into a vehicle processing area, an engine test area, and a space vehicle launch facility for Firefly Aerospace, Inc. The EA process has identified certain actions associated with the Proposed Action that may affect federally listed threatened and/or endangered species. In accordance with the Endangered Species Act, Formal Section 7 Consultation is required for any action that may affect listed species. This Biological Assessment (BA) provides the necessary information required to initiate Formal Section 7 Consultation.

2 PURPOSE AND NEED

The purpose of the Proposed Action is to provide multiple launch pads for commercial users to support Space Florida's CCS Master Plan in accordance with Florida Statutes Section 331 (Space Florida, 2017). Specifically, Space Florida must meet current and future commercial, national, and state space transportation requirements through expansion and modernization of space transportation facilities within its Spaceport territories. The territory includes, but is not limited to, areas within CCAFS. The Proposed Action would allow commercial launch providers such as Firefly to assemble, process, test, and launch vehicles to meet the demand for lower-cost access to space in the legacy SLC-20 disturbed area. The Proposed Action would provide the continued capability of space exploration by commercial users and improve the return on taxpayer investment of CCAFS facilities through expanded use and improved utilization. The Proposed Action would also continue to provide economic and technical benefits to the government and the private sector following the retirement of the Space Shuttle Program in 2011. On November 27, 2018, the Space Florida Board of Directors approved the request to proceed with negotiations and agreements for the redevelopment of SLC-20 to meet Florida's commercial space transportation industry needs.

The Proposed Action is needed to test and launch vehicles efficiently in the United States for use by commercial space launch enterprises. The Proposed Action would contribute to meeting the goals of the CCS Master Plan consistent with the National Space Transportation Policy, NASA's Space Act Agreement, and the Department of Defense (DoD) policy pursuant to DoD Directive 3230.3.

3 INTRODUCTION AND DESCRIPTION OF THE PROPOSED ACTION

The Proposed Action is to twofold: (1) to transfer by RPA approximately 220 acres of land to include SLC-20 and all facilities contained within at CCAFS by the USAF to Space Florida and (2) to sub-license 33 acres of the 220 acres to include the existing launch site infrastructure to Firefly on a dedicated basis. Following execution of a sub-license, Firefly will refurbish and enhance existing SLC-20 facilities, test and operate small- and medium-lift launch vehicles, and transport vehicle stages from Exploration Park to SLC-20.

3.1 PROJECT LOCATION

The project location consists of 220 acres, referred to as the RPA Boundary, that contain the SLC-20 within CCAFS in Sections 5-8 Township 23 South, Range 38 East, Brevard County, Florida (Figures 3-1 and 3-2). The SLC-20 developed launch site consists of 14 facilities (Table 3-1 and Figure 3-3) and is within the northeast portion of CCAFS off ICBM Road between SLC-19 and SLC-34. The remainder of the RPA Boundary area is primarily oak/palmetto.

Figure 3-1 Location Map

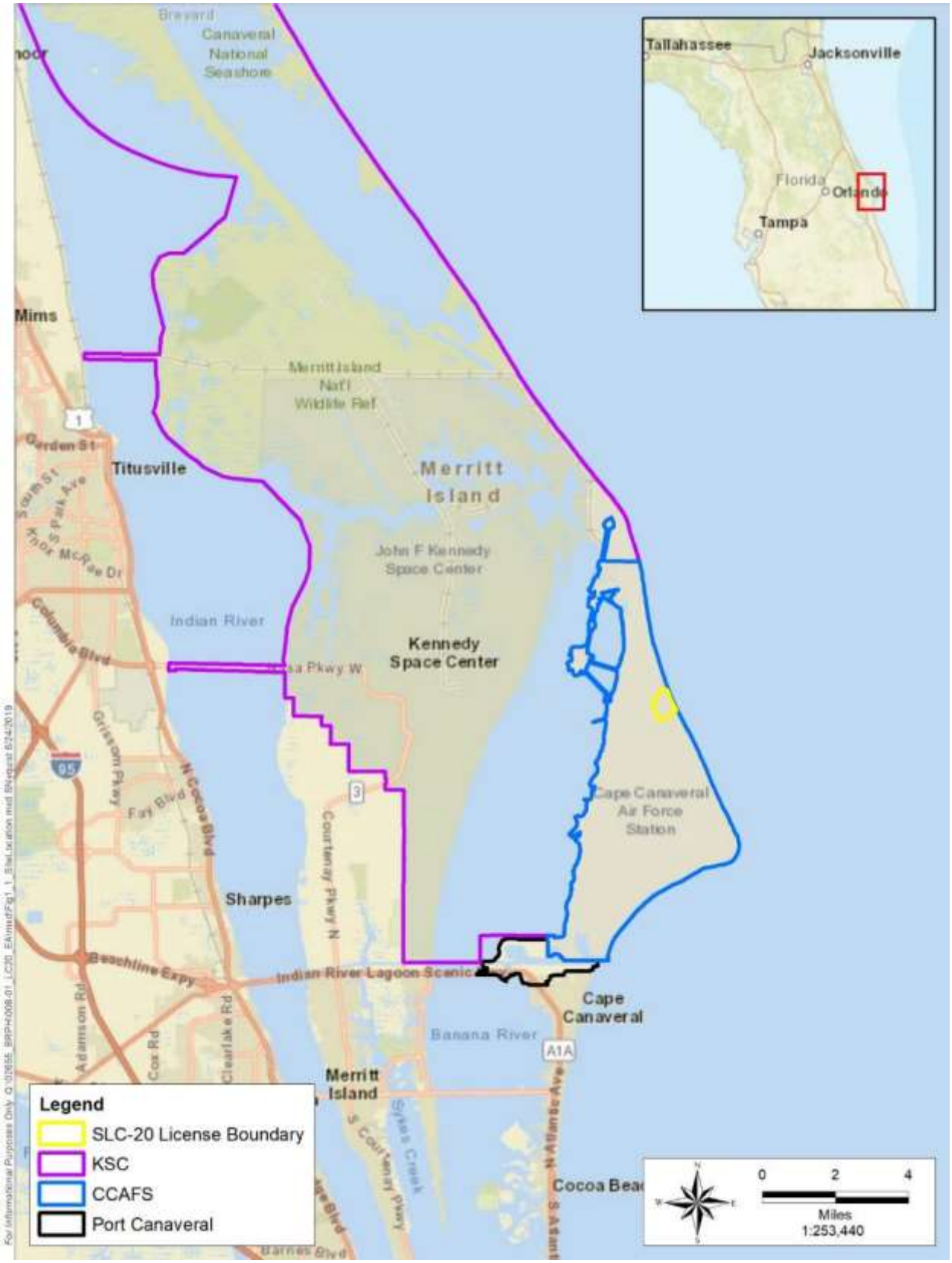
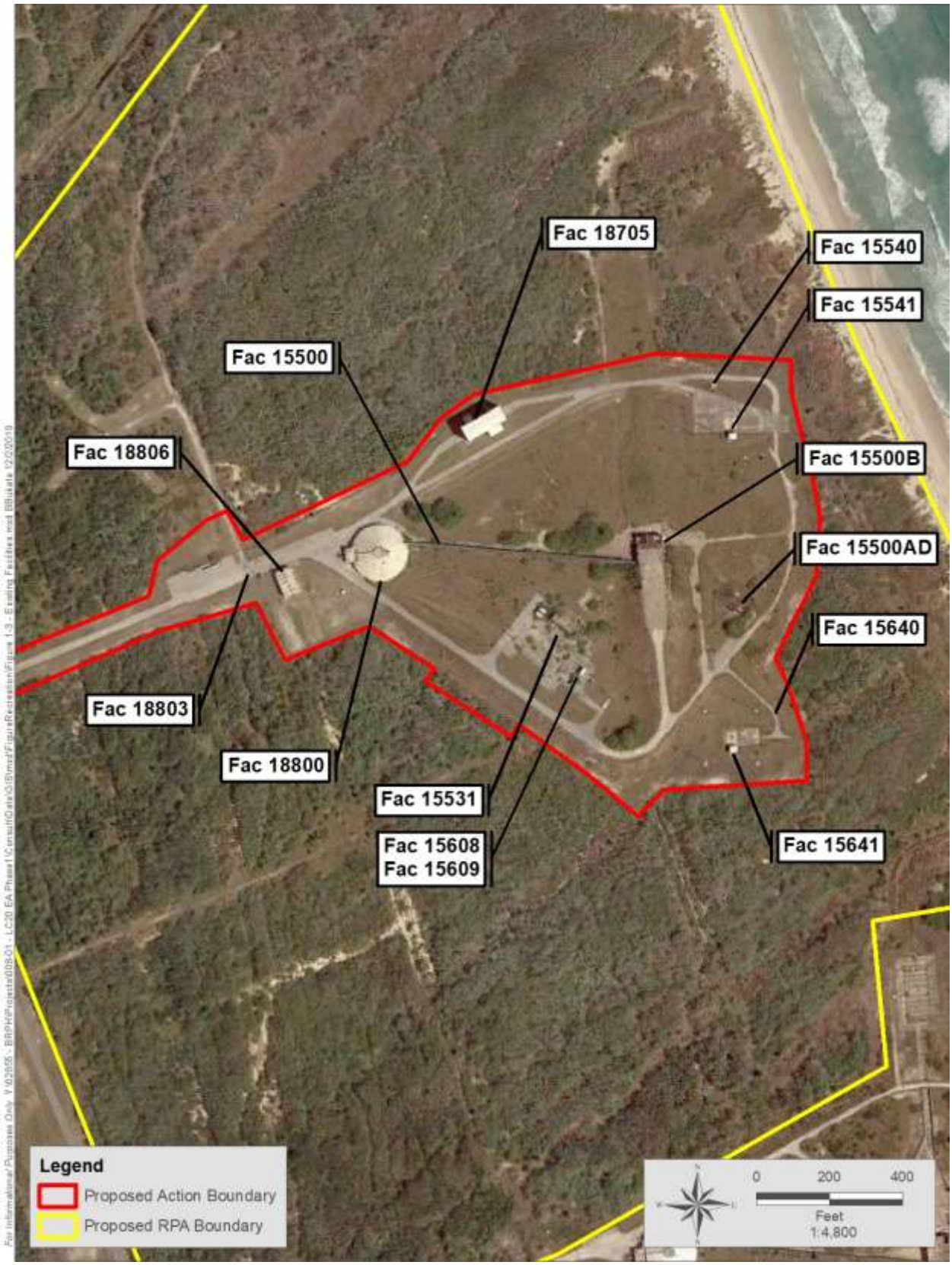


Figure 3-2 Aerial Map

Table 3-1 Existing SLC-20 Facilities

Original Site Facility Name	Current Name	Year Built	Status
15500, Control Cableway	15500, Control Cableway	1959	The structure's setting and design remains intact.
15500AD, Fuel Holding Area	15500AD, Liquid Hydrogen Holding Area	1963	All that remains today is the earthen berm, concrete walls, above-ground storage tank holding area, and truck parking area.
15500AF, Oxidizer Holding Area	15531, Retaining Wall	1962	All that remains of the original facility is the earthen berms and concrete retaining walls.
15500B, Launch Stand and Ramp	15500B, Launch Stand and Ramp	1959	Very little of the original components remain.
15540, Launch Pad A – Ballistic Missile Development Office	15540, Launch Pad A – Ballistic Missile Development Office	1989	The facility is now abandoned in-place and essentially unchanged. The launch rail has been removed and only the mounting ring remains.
15541, Equipment Building Pad	15541, Equipment Building	1989	The facility remains abandoned in-place and essentially unchanged.
15608, Power Center	15603, Power Center	2003	The facility served as an instrumentation facility until it was abandoned in-place in 2010.
15609, Control Center	15609, Control Center	2003	The facility served as an instrumentation facility until it was abandoned in-place in 2010.
15640, Launch Pad B – Ballistic Missile Development Office	15640, Launch Pad B – Ballistic Missile Development Office	1989	The facility remains abandoned in-place and essentially unchanged. The launch rail has been removed and only the mounting ring remains.
15641, Equipment Building Pad A	15641, Equipment Building	1989	The facility remains intact.
18705, Warehouse	18705, Warehouse	1999	The building remains intact.
15500A, Blockhouse	18800, Blockhouse	1959	Although abandoned in-place in 2012, the building remains intact.
18803, Guard House	18803, Guard House	1999	This structure is in a ruinous state of condition.
15500C, Ready Building	18806, Payload Assembly Building	1959	The building is abandoned and in a state of disrepair.

Figure 3-3 Existing Facilities Map



3.2 LAUNCH VEHICLES

Space Florida proposes to establish a multi-user launch capability at SLC-20. Firefly, one of the potential launch providers, proposes to launch Alpha, a small-lift class launch vehicle, and future Beta, a small- to medium-lift class launch vehicle from SLC-20. Firefly's Alpha and Beta launch vehicles will be used as representative vehicles for the Proposed Action and will be subsequently referred to as Concept A and Concept B, respectively. Both representative launch vehicles are expendable and provide satellite delivery services with the future opportunity for lunar surface delivery services. The following describes each vehicle. Table 3-2 summarizes general specifications for both launch vehicles.

Table 3-2 Launch Vehicle Specifications

Specification	Concept A	Concept B (Future)
Length	95 ft (29 m)	140 ft (43 m)
Diameter	6 ft (2 m)	10 ft (3.1 m)
Stages	2	2
Recoverable First Stage	No	No
Parachute Required?	No	No
First Stage Propellant	LO_X/RP-1	LO_X/RP-1/LCH_4
Total Wet Mass	120,000 lb (54,000 kg)	470,000 lb (214,000 kg)
First Stage Thrust	730 kN (163,888 lbf)	2,760 kN (620,000 lbf)

Notes: ft = feet; kg = kilogram; kN = kilonewtons; lbf = pound-force; lb = pounds; LCH_4 = liquid methane; LO_X = liquid oxygen; m = meter; RP-1 = Rocket propellant -1.

3.2.1 CONCEPT A LAUNCH VEHICLE

The Concept A launch vehicle is a small, unmanned, light-lift, two-stage, liquid-fueled launch vehicle with a gross lift-off weight of approximately 120,000 lb (81,647 kg) that can carry payloads between 1,323 lb (600 kg) and 2,205 lb (1,000 kg), depending on the orbit. The first and second stages use only liquid oxygen (LO_X) and rocket propellant-1 (RP-1), which is highly refined kerosene.

The first stage consists of a cylindrical structure containing LO_X and RP-1 tanks separated by an intertank. This first stage is powered by four 182-kN (40,972-lbf) thrust LO_X/RP-1 engines. Roll control and thrust vector control use hydraulic actuators and the on-board RP-1 for its fuel. The engine is a 70-kN (15,714-lbf) thrust engine with hot helium attitude control and hydraulic actuators for thrust vector control.

Concept A may carry small payloads of up to 2,205 lb (1,000 kg) consisting mostly of non-hazardous materials. Some payloads may use small amounts of hazardous propellants for on-orbit maneuvering. These propellants for payloads may include hypergolic fuels such as hydrazine, pressurized gases including helium and nitrogen, and some solid propellants. Hazardous material quantities would vary. In addition, a small amount of ordnance such as small explosive bolts and on-board batteries are typical. Payload propellants will be stored before use in a certified facility near the payload processing facility where the loading will occur. Residual propellants for payloads will be returned to the storage facilities.

Two potential paths for flight termination exist. If the Concept A launch vehicle varies from its planned trajectory, the launch vehicle will be equipped with a destructive flight termination system. Preliminary flight safety analysis will determine the flight termination system type. The expected destructive termination system includes two linear-shaped charges that are intended to rupture the vehicle tanks when commanded to destruct, thereby dispersing propellants and breaking up the vehicle to minimize the impact to ground assets.

A second option if approved would be thrust termination. A thrust termination system commands the shutdown of the vehicle engines. Upon activation of the thrust termination system, the Concept A launch vehicle would fall to the ocean possibly intact and, depending on the circumstances and time in the flight of the termination, may explode upon impact. If later in flight, the Concept A launch vehicle would likely break up from aerodynamic loading of the airframe dispersing propellants similar to a destruct termination system.

The Proposed Action includes a non-destructive software and telemetry testing of the flight termination systems. No ascent abort testing of the launch vehicle is proposed nor is the destructive testing of the ordnance flight termination system or thrust termination system.

3.2.2 Concept B Launch Vehicle

The Concept B launch vehicle shares the same basic design as the Concept A launch vehicle with higher thrust, providing a higher payload capacity that can carry between 7,275 lb (3,300 kg) and 12,787 lb (5,800 kg) depending on orbit. Concept B will also use liquid propellants LO_x and RP-1.

4 SITE DEVELOPMENT

Site development will occur on 33 acres (13.2 ha) of the approximately 220-acre (88-ha) RPA Boundary, and the majority of site development/refurbishment will occur within the existing disturbed legacy SLC-20 footprint (Figure 3-2).

The Proposed Action's Launch Vehicle Program is designed for minimal vehicle assembly or processing on the launch pad, and most of the vehicle assembly will occur at Exploration Park. Launch vehicle stages and payloads will arrive at SLC-20 from Exploration Park via heavy truck (tractor-trailer). Development of Exploration Park was previously addressed by an Environmental Assessment (NASA, 2008).

Space Florida intends to refurbish, enhance, and use the existing SLC-20 support shop, Horizontal Integration Facility (HIF), and blockhouse. The Proposed Action will reuse and likely resurface and/or improve existing impervious surface areas for planned roads and structures. Proposed new facilities and supporting infrastructure are summarized in Table 4-1 and are depicted on Figure 4-1. Site development will take place over three phases of construction.

The new HIF/hazardous payload processing facility along the southwest region of the Proposed Action Boundary is the only new construction that requires clearing outside the legacy SLC-20 footprint. The new HIF will result in clearing of 0.3 acre of undisturbed upland habitat (Figure 4-1). Remaining areas are impervious or previously disturbed and now dominated by ruderal and exotic plant species. These areas are expected to be maintained by mowing on a periodic basis using standard large-scale grass mowing equipment.

4.1 LAUNCH-RELATED OPERATIONS

Payload preparation activities would be conducted in parallel with most launch vehicle preparations. Payload activities include payload checkout, spacecraft propellant loading (if required), and payload encapsulation in the fairings. The encapsulated payload would then be transported to SLC-20. Non-hazardous and hazardous payload processing and encapsulation would take place in the existing HIF for the Concept A launch vehicle. However, following construction of the new HIF, hazardous payload processing would transition to the new facility.

4.2 LAUNCH EVENTS

Space Florida expects up to 24 total Concept A/B launches. To be conservative in determining noise-related impacts, all 24 annual launches are assumed to be from Concept B launch vehicles. Seventy percent of the launches are expected to occur during daylight hours and 30 percent of the launches are expected to occur during night hours. Night is defined as any event occurring after 10 p.m. and before 7 a.m.

Table 4-1 Proposed New Construction

Phase	New Facility	Historical Site
Phase 1	Concept A Pad	Fac 15540, Launch Pad A
	Concept A Launch Equipment	Fac 15541, Equipment Building Pad A
	Deluge Containment	New Construction Near Former Facilities 15540 and 15541
	Concept A ECS	New Construction
	Rocket Propellant 1 and Gaseous Nitrogen Storage	Facility 15500AD, Fuel Holding Area
	Ordnance Storage	New Construction Near Former Facility 15640, Launch Pad B
	Liquid Oxygen, Liquid Nitrogen, and Gaseous Helium	Facilities 15608, Power Center; 15609, Control Center; and 15531, Retaining Wall (Former Oxidizer Holding Area)
	Generators	New Construction Near Facility 18800, Blockhouse
	Launch Communication Equipment and Pad Office	New Construction Near Facility 18800, Blockhouse
	Support Shop	Facility 18806, Payload Assembly Building
	Pad Security	Facility 18803, Guard House
	Non-hazardous Payload Process Facility	Facility 18705, Warehouse
	Horizontal Integration Facility	
Phase 2	Complex Support Building/Office	New Construction
	Deluge Containment	
	Concept A/B Pad	Facility 15500B, Launch Stand and Ramp
	Concept B ECS	
	Concept B Launch Equipment	
	New Horizontal Integration Facility/Hazardous Payload Processing Facility	New Construction
	Water Pump House	New Construction
Phase 3	Customer Support Building/Office	New Construction

Figure 4-1 Proposed Facilities Map

5 DESCRIPTION OF THE AREA IMPACTED BY THE PROPOSED ACTION

The Proposed Action will repurpose the existing SLC-20 complex within the historical fence-line and require development of a 0.3-acre undisturbed area along the southwest boundary for the construction of a new HIF. In July 2019, a pedestrian survey was completed of the proposed RPA Boundary to map vegetation communities, determine the presence of jurisdictional wetlands and surface waters, and document the presence/absence of, or habitat that could support, listed wildlife species.

5.1 LAND COVER

The land cover within the Proposed Action Boundary and RPA Boundary were categorized using the CCAFS 45th Space Wing habitat designations. The project area is composed of three upland communities, two wetland communities, and one surface water community (Figure 5-1). Table 5-1 summarizes the habitat designations and acreages, and describes each unique habitat.

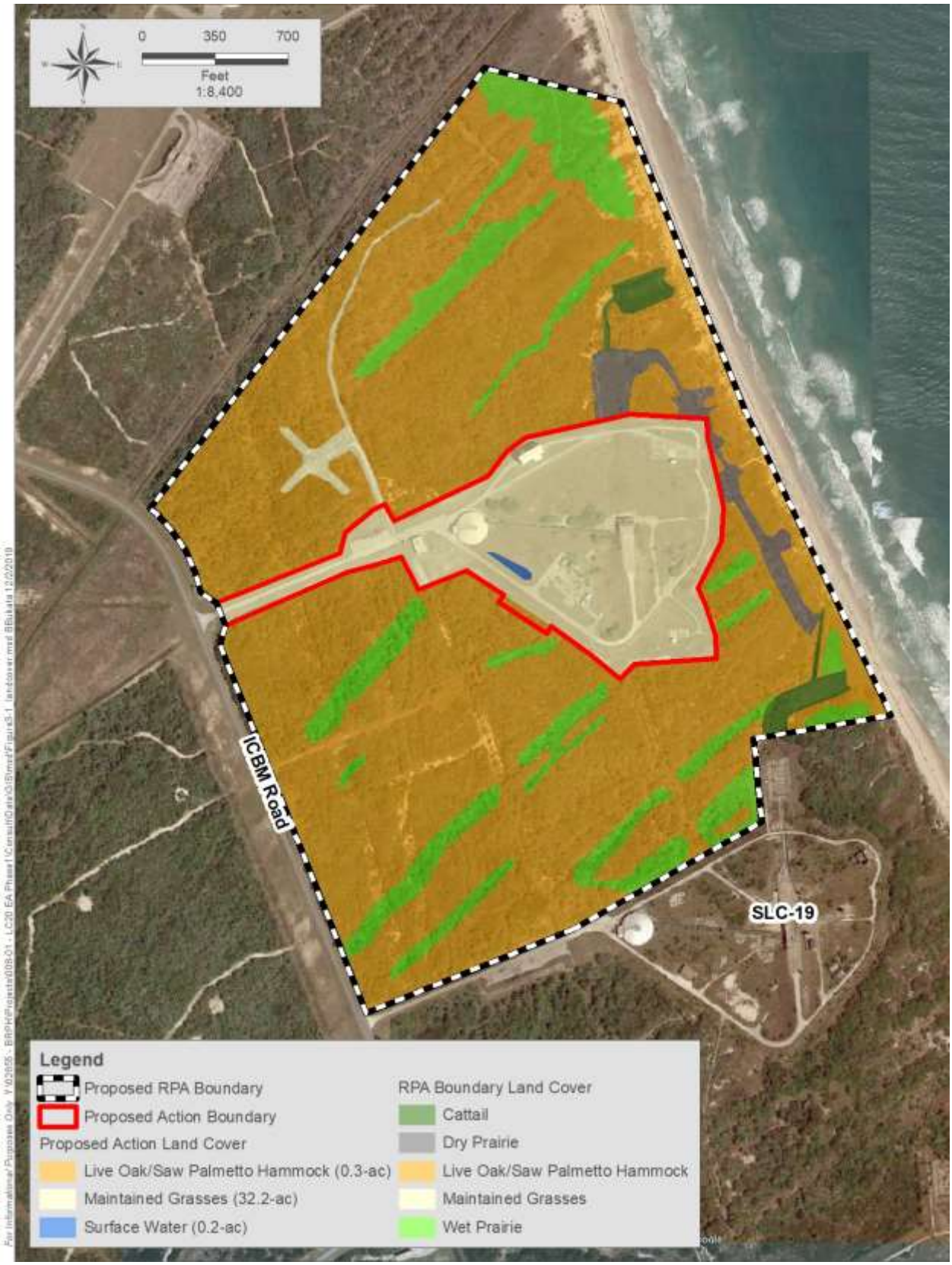
5.1.1 UPLANDS

The following three upland habitats are found within the SLC-20 RPA and Proposed Action Boundary: (1) Maintained Grasses, (2) Dry Prairie, and (3) Live Oak/Saw Palmetto Hammock (Figure 5-1).

Maintained Grasses comprises 32.2 acres (13.0 ha) within the Proposed Action Boundary and refers to areas of impervious surface such as roads, buildings, and disturbed vegetated areas within legacy SLC-20 area that have been maintained inconsistently. Vegetated areas within the Proposed Action area is dominated by a diversity of native and exotic species such as ragweed (*Ambrosia artemisiifolia*), beggars tick (*Bidens pilosa*), frogfruit (*Phyla nodiflora*), muhly grass (*Muhlenbergia capillaris*), Bermuda grass (*Cynodon dactylon*), bahia grass (*Paspalum notatum*), alamo vine (*Merremia dissecta*), mother of thousands (*Kalanchoe daigremontiana*), sunflower (*Helianthus debilis*), lantana (*Lantana* sp.), century plant (*Agave americana*), prickly pear cactus (*Opuntia humifusa*), morning glory (*Ipomea* sp.), partridge pea (*Chamaecrista fasciculata*), and winged loosestrife (*Lythrum alatum*) (Photograph 5-1). Several large clumps of Brazilian pepper (*Schinus terebinthifolius*) are also found in the central and south region with a few scattered live oak (*Quercus virginiana*) and hog plum (*Ximenia americana*). In addition, several large areas of St. Augustine grass (*Stenotaphrum secundatum*) exist throughout the site as well as a large monoculture of guinea grass (*Megathyrsus maximus*) (Photograph 5-2).

The second upland community, Dry Prairie, is found in the east region of the RPA Boundary and is dominated by various upland herbaceous and shrub species such as Brazilian pepper, St. Augustine grass, bahia grass, ragweed, beggars tick, frogfruit, muhly grass, partridge pea, and winged loosestrife. These areas were also likely previously cleared and disturbed for historical launch operation activities.

Figure 5-1 Existing Land Cover



Photograph 5-1 South Side of SLC-20

Photograph 5-2 North Portion of SLC-20 Looking North Toward Existing HIF

Table 5-1 Summary of Land Cover Types

Site	Land Cover Description	Acreage*
Proposed Action	Maintained Grasses	32.2 (13.0)
	Oak/Palmetto	0.3 (0.1)
	Wet Prairie	0.19 (0.08)
		33.0 (13.2)
RPA Boundary	Maintained Grasses	2.2 (0.9)
	Dry Prairie	4.2 (1.7)
	Oak/Palmetto	155.1 (62.0)
	Marsh - Freshwater	2.5 (1.0)
	Wet Prairie	23.0 (9.2)
		187.0 (74.8)
	Total=	**220.0 (88)**

*Hectares in parenthesis.

The third upland community, Oak/Palmetto, is found in the southwest region of the Proposed Action area and comprises approximately 0.3 acre (Figure 5-1) (Photograph 5-3). This community is dominated by live oak (*Quercus virginiana*), sabal palm (*Sabal palmetto*), saw palmetto (*Serenoa repens*), grape vine (*Vitis* sp.), and greenbriar (*Smilax* sp.).

Photograph 5-3 Coastal scrub Facing South from Launch Pad Access Road

5.1.2 WETLANDS

The two wetland communities found within the RPA are Wet Prairie and Marsh – Freshwater (Figure 5-1). The Wet Prairie community found throughout the RPA Boundary is dominated by Brazilian pepper, sand cordgrass (*Spartina bakerii*), lateflowering thoroughwort (*Eupatorium serotinum*), winged loosestrife, broomsedge (*Andropogon glomeratus*), sawgrass (*Cladium jaimacense*), frogfruit, and foxtail (*Seteria* sp.). Surface water was not present, soils were extremely dry, and hydric soil indicators consisted of sandy redox (S5). Due to the lack of an organic horizon at the surface, these wetlands are not expected to experience prolonged inundation during the wet seasons; rather, the water table is found at or below grade. The second wetland community, Marsh – Freshwater, is in the northeast and southeast corners of the RPA Boundary (Figure 5-1). This community is dominated by dense cattail.

5.1.3 SURFACE WATERS

This community comprises 0.2 acre and is in the southwest region of the Proposed Action Boundary. It is an upland cut roadside drainage swale that is dominated by frog-fruit, St. Augustine grass, pennywort (*Hydrocotyle umbellata*), and sedges (*Cyperus* sp.).

Figure 5-2 presents a light detecting and ranging-derived digital elevation model (DEM) topographic map for the Proposed Action.

Figure 5-2 Topographic Map

6 LISTED WILDLIFE SPECIES

Table 6-1 summarizes the listed wildlife species that may be potentially impacted as a result of the Proposed Action based on field investigations, existing data, and habitats found within the Proposed Action or RPA Boundary area.

6.1 FLORIDA SCRUB-JAY

The Florida scrub-jay is a federally threatened bird endemic to open, oak-dominated scrub habitats of Florida. Widespread loss and degradation of scrub habitat over the last century have resulted in dramatic declines in the distribution and abundance of this species. Populations of this species that remain are small, demographically isolated, and likely to decline. One of three core populations that contains over half of the State's remaining scrub-jays is found at Kennedy Space Center (KSC)/CCAFS (USAF, 2018a). The 45th Civil Engineering Squadron, Environmental Conservation Element (45 CES/CEIE-C) is the organization within the 45th Space Wing with primary responsibility for overseeing Florida scrub-jay management and handling Section 7 consultations with the US Fish and Wildlife Service (USFWS) as required under the Endangered Species Act.

The SLC-20 RPA Boundary is in Land Management Units (LMU) 15 and 18. The Proposed Action site contains 0.3 acre (0.1 ha) of coastal scrub habitat that is considered poor quality (Figure 6-1) (USAF, 2018a). However, in the future the 45th Space Wing may conduct controlled burns and mechanical vegetation management to improve the coastal scrub habitat within the RPA Boundary up to the Proposed Action Boundary.

USAF conducts a yearly census of the Cape Canaveral population of scrub-jays in all suitable accessible jay habitat. In 2018, 136 Florida scrub-jay groups were identified, which has varied from 104 groups in 2000 to 157 groups in 1996 and 1997 (Figures 6-1 and 6-2). Data from the 2018 census indicate the presence of a single group within the RPA Boundary area just east of ICBM Road but over 1,100 feet west of the Proposed Action Boundary (Figure 6-3).

As previously stated, the Proposed Action will impact 0.3 acre (0.1 ha) of low-quality Florida scrub-jay habitat dominated by sand live oak and saw palmetto (Figure 6-3). The remaining disturbed areas do not support the Florida scrub-jay.

Table 6-1 Potential Impacts, Section 7 Finding, and Compensation to Federal and State Protected Wildlife Species that Occur or Have Potential to Occur within the Proposed Action Area (Area defined as direct or indirect impact by construction or operations)

Common Name *Scientific Name*	Status[1] USFWS	Status[1] FFWCC	Occurrence	Potential Impacts	Section 7 Finding	Compensation
Florida Scrub-Jay *Aphelocoma coerulescens*	T	T	Potential	Reduced restoration of suitable habitat.	May Affect, But Not Likely To Adversely Affect	Habitat restoration near SLC-19, change in 45 SW operational controls to ensure burn days, and continued habitat restoration on CCFAS.
Gopher Tortoise *Gopherus polyphemus*	C	T	Documented	Crushing by equipment. Loss of habitat.	NA	Affected individuals to be relocated.
Eastern Indigo Snake *Drymarchon corais couperi*	T	T	Potential	Crushing by equipment.	May Affect, But Not Likely To Adversely Affect	Continued habitat restoration on CCAFS.
Southeastern Beach Mouse *Peromyscus polionotus niveiventris*	T	T	Documented	Crushing by equipment. Disruption due to noise.	May Affect and Is Likely To Adversely Affect	Continued habitat restoration on CCAFS.
Marine Turtle: Leatherback (*Dermocheyls coriacea*) Green (*Chelona mydas)* Loggerhead (*Caretta caretta*) Kemps Ridley (*Lepidochelys kempii*) Hawksbill (*Eretmochelys imbricata*)	 E T T E E	 E T T E E	Documented	Disruption and disorientation due to light.	May Affect and Is Likely To Adversely Affect	Implement exterior lighting compliant management plans.
West Indian Manatee *Trichechus mantus*	T	T	No habitat	No impacts	No Affect	NA
American Alligator *Alligator mississippiensis*	S/A		No habitat	No impacts	No Affect	NA
American Wood Stork *Mycteria americana*	T	T	Potential	Disruption of foraging habitat. Disruption due to noise.	May Affect But Not Adversely Affect	Impacts to wetlands will be mitigated in accordance with state and federal wetland regulations.
Piping Plover *Charadrius melodus*	T	T	Potential	Disruption due to noise.	May Affect But Not Adversely Affect	None provided.
Red Knot *Calidris canutus*	T		Potential	Disruption due to noise.	May Affect But Not Adversely Affect	None provided.

Note [1]: Legend: (C) Candidate; (T) Threatened; (E) Endangered; (S/A) Similarity of Appearance.
FFWCC = Florida Fish and Wildlife Conservation Commission.

Figure 6-1 2018 Florida Scrub-Jay Census Map

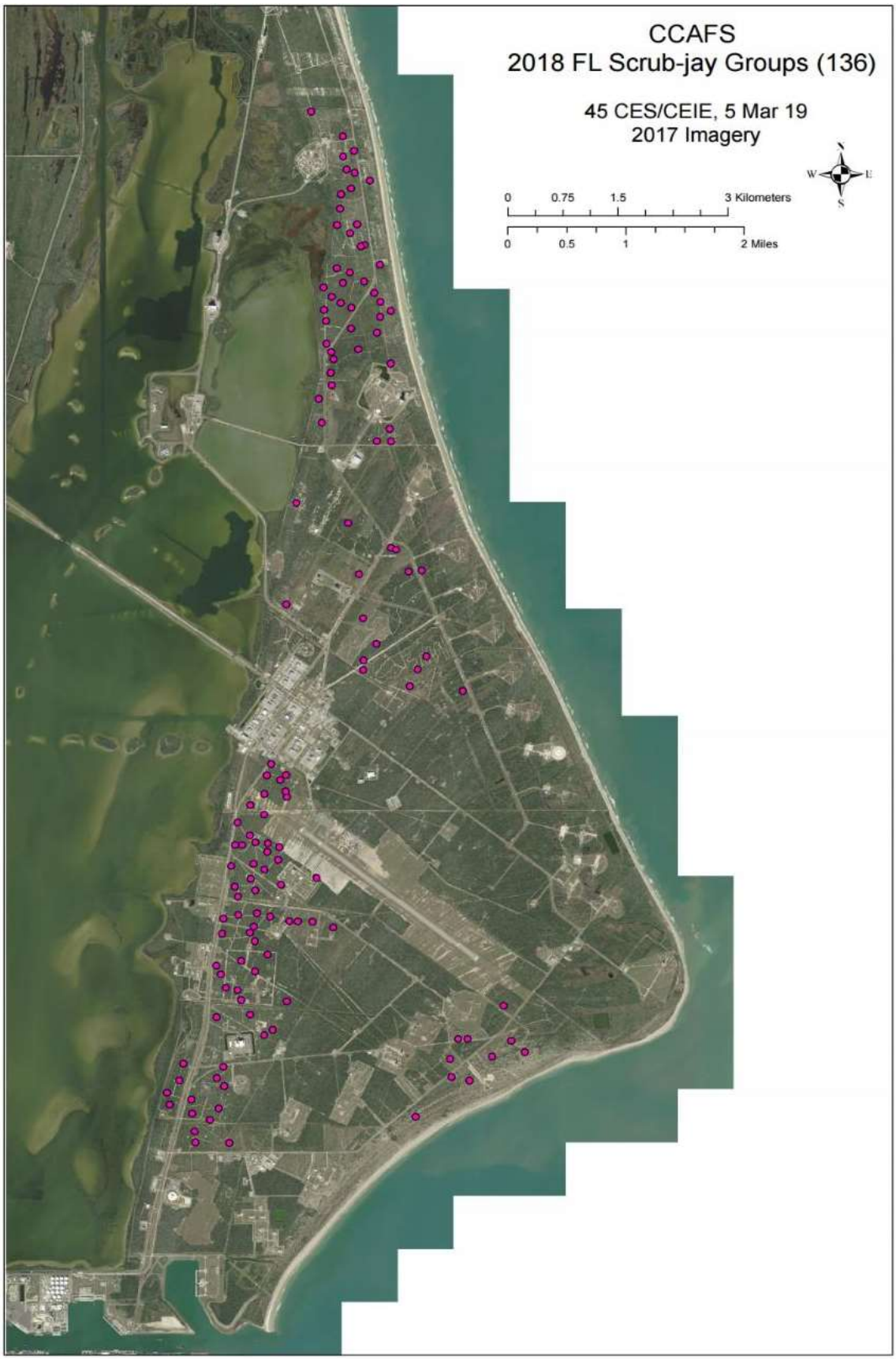


Figure 6-2 CCAFS Florida Scrub-Jay Annual Census Totals (USAF, 2019)

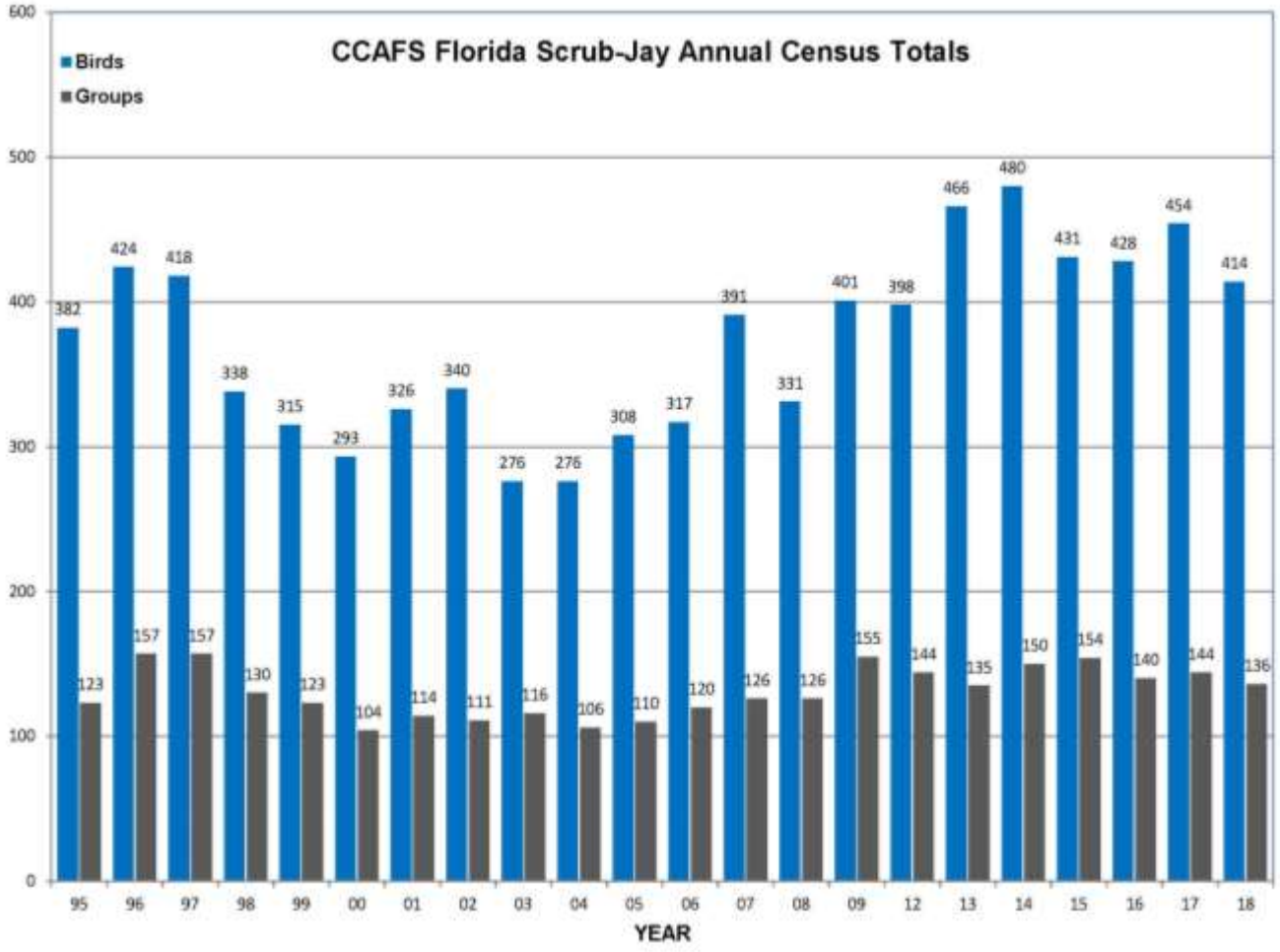


Figure 6-3 Proposed Florida Scrub-Jay Habitat Impacts and Census Data

6.2 GOPHER TORTOISE

The gopher tortoise is a State-Listed *Threatened* species by FFWCC and is protected by State law, Chapter 68A-27, Florida Administrative Code (FAC). The gopher tortoise is also currently classified as a *Category 2 Candidate Species* by USFWS under the Endangered Species Act. The basis of the *Threatened* classification by FFWCC for the gopher tortoise is due to habitat loss and destruction of burrows. The gopher tortoise can live up to 80 years in the wild and occurs in upland habitats such as sandhills, pine flatwoods, scrub, scrubby flatwoods, dry prairies, xeric hammock, pine-mixed hardwoods, and coastal dunes. Gopher tortoises will dig and use several burrows during the warm months and burrows can range from 3 to 52 feet long. These burrows provide refuge for more than 350 other commensal species such as small mammals, frogs, mice, snakes, and insects.

In July 2019, a pedestrian gopher tortoise survey was completed for approximately 90 percent of the Proposed Action area and approximately 60 percent of high probability habitat in the RPA Boundary. Within the Proposed Action area, a diversity of burrow sizes was observed, from juveniles to large adults (Photographs 6-1 and 6-2), with over 160 potentially occupied (PO) burrows observed within the boundary and 35 observed outside the boundary (Figures 6-4 and 6-5).

Photograph 6-1 Hatchling Gopher Tortoise Burrow Adjacent to Road to Launch Pad

Photograph 6-2 Adult Gopher Tortoise Burrow

Figure 6-4 Proposed Action Boundary PO Gopher Tortoise Burrow Location Map

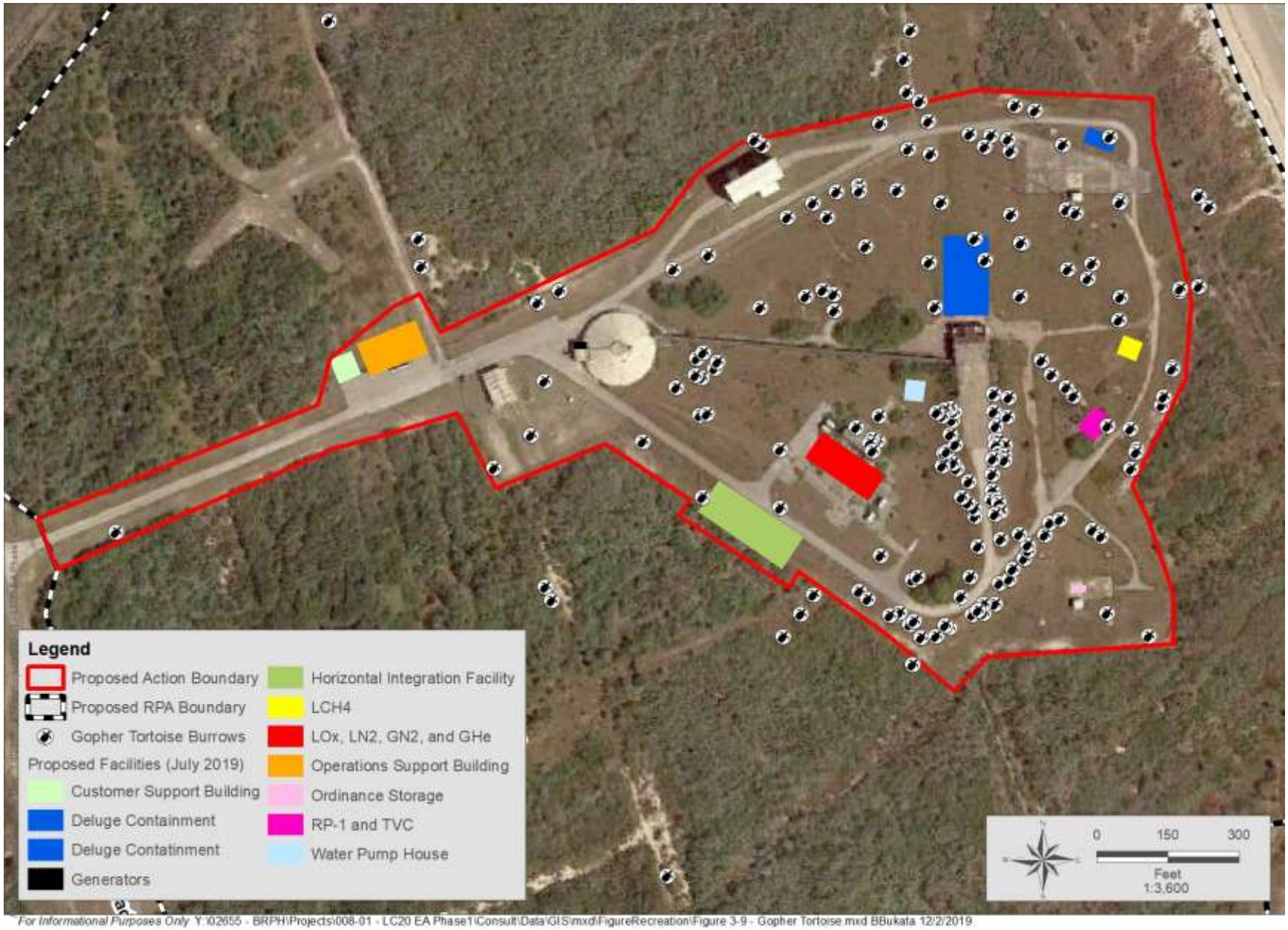


Figure 6-5 Proposed RPA Boundary Area PO Gopher Tortoise Burrow Location Map

6.3 EASTERN INDIGO SNAKE

The eastern indigo snake is a federally *Threatened* species that may attain a length of up to 8 feet. It is found in a diversity of habitats and is closely associated with gopher tortoise burrows, which it uses for shelter during cold weather and extremely dry periods. The eastern indigo snake feeds on other snakes, frogs, salamanders, toads, small mammals, and birds and can have a home range of over 200 acres (USAF, 2018a). The eastern indigo snake has been observed on CCAFS and likely occurs throughout the installation; however, exact numbers are not known. The breeding season occurs between November and April with egg-laying occurring May through June with hatchlings emerging in late July through October. Major threats to the indigo snake on CCAFS are habitat loss and vehicle traffic. An installation-wide census for the eastern indigo snake has not been completed. This species is likely to occur within the Proposed Action Boundary based on the abundance of gopher tortoise burrows. This species is also likely to occur within the RPA Boundary area due to the habitat type and presence of gopher tortoise burrows.

6.4 SOUTHEASTERN BEACH MOUSE

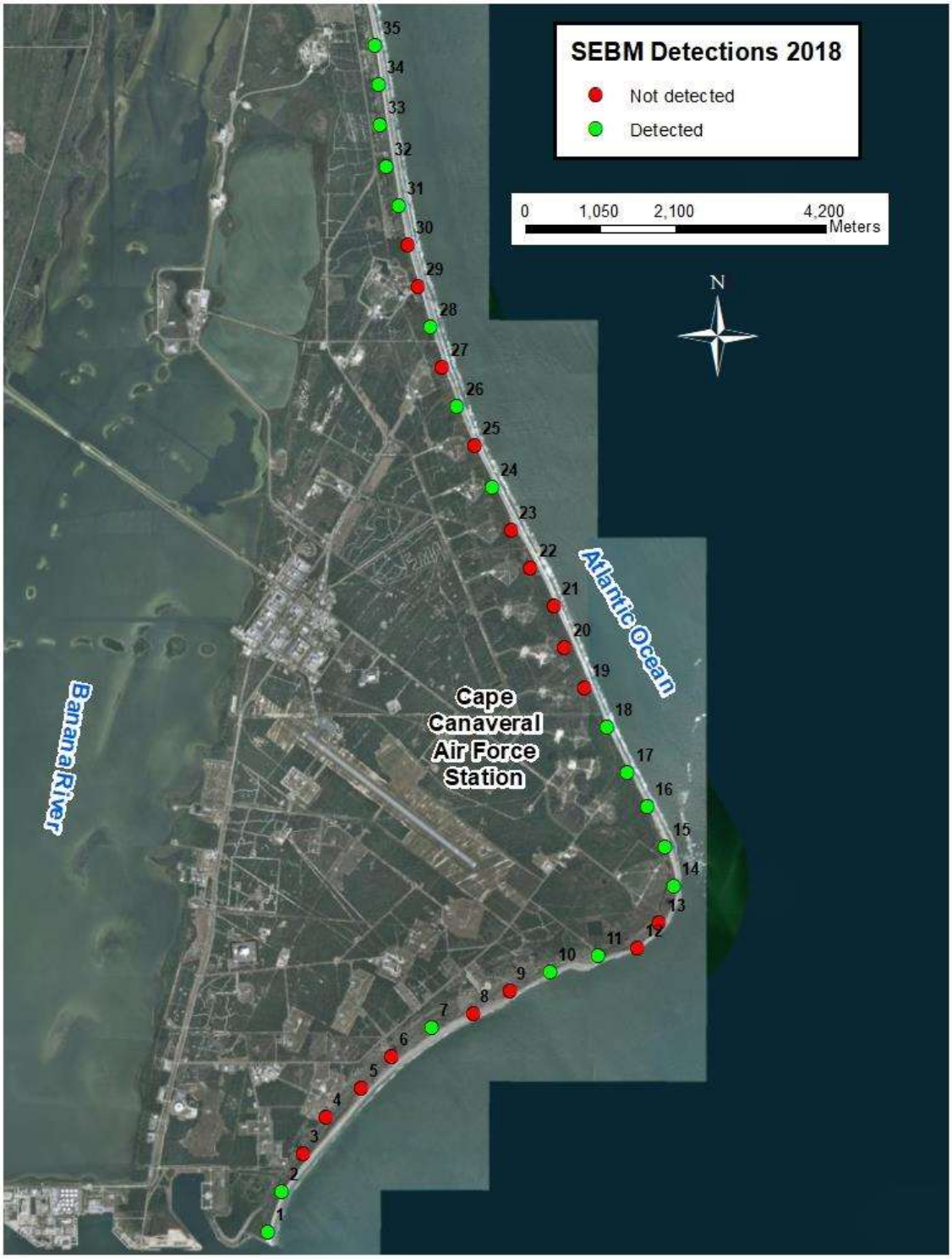
The southeastern beach mouse is a federally *Threatened* subspecies that historically existed on coastal dunes and coastal strand communities from Ponce Inlet south (Volusia County) to Hollywood, Florida (Broward County) (Humphrey et al., 1987). Currently, the southeastern beach mouse is restricted to predominantly federal lands encompassing and adjacent to CCAFS, KSC, Canaveral National Seashore (CNS), the Merritt Island National Wildlife Refuge (MINWR), and a few locations on Pelican Island National Wildlife Refuge and Sebastian Inlet State Park (Oddy et al., 2012). This species is a high priority for management on federal lands encompassing the Cape Canaveral Barrier Island Complex (CCBIC), which includes KSC/MINWR, CCAFS, and CNS.

Reasons for decline in southeastern beach mouse populations include habitat loss due to development and erosion, habitat fragmentation, isolation, competition from the house mouse, and predation from domesticated cats (Stout, 1992). The beach mouse is a monogamous species for which breeding typically occurs November through January with females producing two or more litters per year with an average of three to four offspring per litter.

Biologists have been studying the demographics of this species since the late 1970s with a baseline study of KSC and CCAFS conducted by Stout (1979). Since 2008, biologists have monitored habitat occupancy of the southeastern beach mouse on the CCBIC, with the goal of sampling habitat occupancy annually each fall/winter throughout the entire area of suitable coastal habitat.

A long-term sampling grid (BG3) is north of the Proposed Action area but within the RPA Boundary as well as a 2011 to 2012 random coastal point referred to as 18 (Figure 6-6). Southeastern beach mice were captured at these locations during the 2011 to 2012 sampling period (Oddy et al., 2012). Sampling conducted in 2018 did not detect the presence of this species (Oddy and Stolen, 2018) (Figure 6-7), and results of the sampling determined a habitat occupancy rate of 0.72 percent of CCBIC coastal habitat was occupied. More importantly, several southeastern beach mice were captured inside the SLC-20

Figure 6-6 Locations at which Southeastern Beach Mice were Detected During the Occupancy Survey on CCAFS, February to March 2018



(Green circles indicate that beach mice were detected at a site, and red circles indicate no detection at a site. Numbers indicate site locations.)
(Oddy and Stolen, 2018)

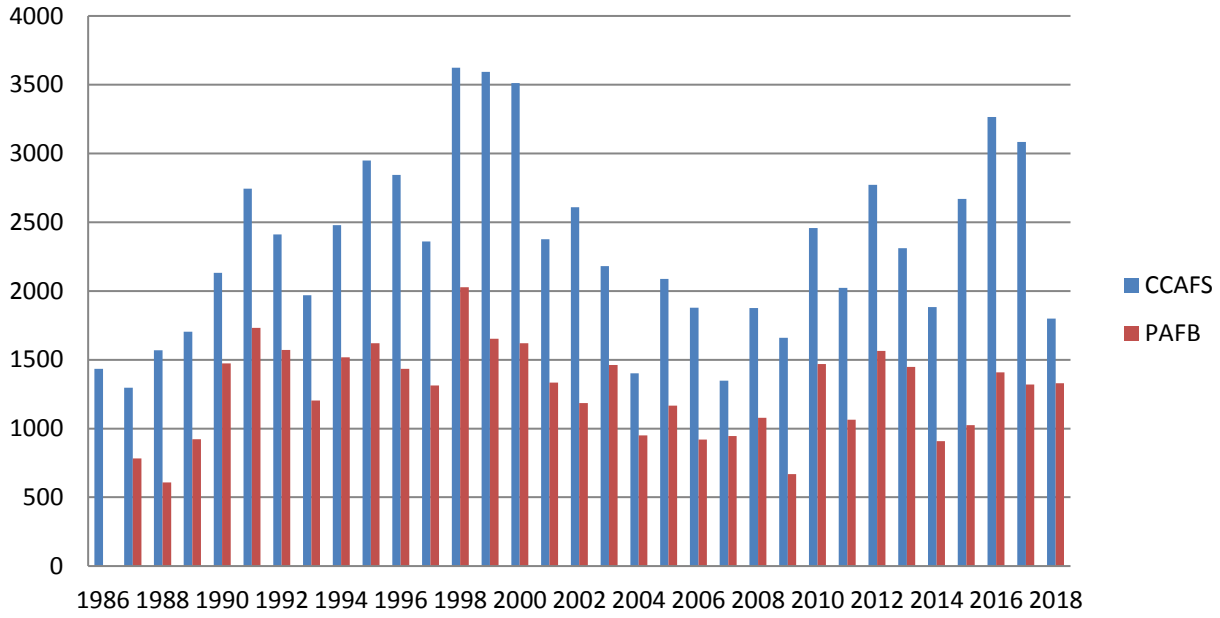
blockhouse (Facility 18800) in 2001 (ESC, 2002). As a result, the presence of this species has been confirmed within the Proposed Action Boundary as well as within the RPA Boundary area.

Figure 6-7 Land Management Units (Blue), Long-Term Grids (Green), and Random Coastal Points (Red) on CCAFS Where Small Mammal Trapping Occurred in Fall 2011 and Spring 2012

6.5 MARINE TURTLES

The loggerhead, green, leatherback, and Kemp's ridley sea turtles nest on the beaches of CCAFS and Patrick Air Force Base (PAFB). In 1986, the 45th Space Wing began sea turtle monitoring at CCAFS and PAFB. Nests are deposited on CCAFS and PAFB each year between April and September. Each year, between 1,400 to 3,600 sea turtle nests are deposited on the 13 miles of beach at CCAFS based on nest surveys at CCAFS from 1986 through 2018 (Figure 6-8) (USAF, 2018b).

Figure 6-8 All Sea Turtle Nests Deposited at CCAFS and PAFB



Although sea turtles spend much of their lives in the ocean, females come ashore each year to nest. Preliminary research indicates that lights adjacent to sea turtle nesting beaches may hinder the beach nest site selection of nesting females. Regarding sea turtle hatchlings, extensive research has demonstrated that the principal component of the emergent sea turtle hatchlings' orientation behavior is visual (Carr and Ogren, 1960; Dickerson and Nelson, 1989; Witherington and Bjorndal, 1991). Artificial beachfront lighting has been documented to cause disorientation (loss of bearings) and misorientation (incorrect bearing) of hatchling turtles. As hatchlings head toward artificial lights, their exposure to predators and the likelihood of dehydration are greatly increased. Misoriented hatchlings can become entrapped in vegetation or debris, and some hatchlings have been found dead on nearby roadways and in parking lots after being struck by vehicles. Intense artificial lighting can even draw hatchlings back out of the surf (USAF, 2018b).

In 1988, in compliance with Section 7 of the Endangered Species Act, USAF developed Light Management Plans (LMPs) for various areas and facilities on CCAFS to protect sea turtles. A Biological Opinion (BO) issued by USFWS in April 1991, with several subsequent revisions, requires LMPs for any new facilities that are close to the beach, are not constructed in accordance with 45th Space Wing Instruction (SWI) 32-7001, have lighting directly visible from the beach, and/or may cause significant sky glow. The BO was modified again in 2008 and authorized a 3-percent take of nesting females and up to 3 percent of all hatchlings

disoriented/misoriented from a representative sample of all surveyed marked nests. The BO also requires at least five night light surveys at CCAFS and PAFB during the peak of nesting season (May 1 through October 31). Currently, no exterior lighting operates at SLC-20 and no disorientation has been documented on the beach in this area for several years.

6.6 West Indian Manatee

The West Indian manatee is listed as *Endangered* by USFWS. Manatees are protected under the Marine Mammal Protection Act, which prohibits the take (i.e., harass, hunt, capture, or kill) of all marine mammals. Manatees are found in marine, estuarine, and freshwater water bodies. The West Indian manatee includes two distinct subspecies; the Florida manatee *(Trichechus manatus latirostris)* and the Antillean manatee *(Trichechus manatus manatus)*. Although morphologically distinctive, both subspecies have many common features such as large, seal-shaped bodies with paired flippers and a round, paddle-shaped tail. They are typically grey (color can range from black to light brown) and occasionally spotted with barnacles or colored by patches of green or red algae. The muzzle is heavily whiskered and coarse, single hairs are sparsely distributed throughout the body. On average, adult manatees are approximately 9 feet long (3 meters) and on average weigh 1,000 lb (200 kg). At birth, calves are between 3 and 4 feet long (1 meter) and weigh between 40 and 60 lb (30 kg).

No surface waters exist for the West Indian manatee within the Proposed Action or RPA Boundary areas. However, this species could use coastal waters of the Atlantic Ocean to the east.

6.7 American Alligator

The American alligator is federally listed as *Threatened* due to its similarity in appearance to other endangered species such as the American crocodile (*Crocodylus acutus*). The American alligator has made a strong recovery in Florida and inhabits and reproduces in nearly all CCAFS waters. Alligators are apex predators and consume fish, amphibians, reptiles, birds, and mammals. They play an important role as ecosystem engineers in wetlands through the creation of alligator holes, which provide wet and dry habitats for numerous other organisms.

The Proposed Action area does not contain wetland or surface water habitat that could support this species. However, the RPA Boundary area does contain two cattail-dominated ponds that could support the American alligator (Figure 5-1).

6.8 American Wood Stork

The American wood stork is a federally listed *Threatened* species and is the only stork species found in North America. It is a large, white and black wading bird, with a long 'ibis-shaped' beak. Wood storks forage in small pools and wetland areas that support small fish. The species breeds in late winter once fish populations in small vernal pools have dried up sufficiently to support the raising of young.

The Proposed Action area does not contain wetland or surface waters that would be used by the American wood stork. However, the proposed RPA Boundary area does contain two

cattail-dominated ponds and several depressional wetlands that could provide marginal foraging habitat for use by the American wood stork.

6.9 Piping Plover

The piping plover, a federally listed *Threatened* species, is a small sand-colored, sparrow-sized shorebird that nests and feeds along coastal sand and gravel beaches in North America. The adult has yellow-orange legs, a black band across the forehead from eye to eye, and a black ring around the neck. Their breeding habitat includes beaches or sand flats on the Atlantic coast, Great Lakes, and the mid-west. They forage for food on beaches moving across in short bursts around the high-tide wrack zone eating insects, marine worms, and crustaceans.

The piping plover is not known to breed in Brevard County; however, it does have the potential to occur on Brevard beaches during the non-breeding season (July to March) and has been previously observed on CCAFS beaches in small numbers.

6.10 Red Knot

The red knot is a federally listed *Threatened* species and is a medium-sized shorebird that breeds in tundra and the Arctic Cordillera in the far north of Canada, Europe, and Russia. The red knot has one of the longest migrations of any bird. The red knot is an occasional visitor along the Florida seashore during its annual migration. This species is not known to breed or nest in Brevard County; however, it has been previously observed on CCAFS beaches in small numbers.

7 EFFECTS OF ACTION ON LISTED SPECIES

The following sections discuss specific effects from the Proposed Action. Effects are caused by construction and operations activities. Envisioned impacts include construction and operation activities associated with the launch of the Concept A and B launch vehicles. Potential impacts to listed species have been significantly minimized by siting facilities/ structures in cleared and disturbed areas associated with the legacy SLC-20. The only proposed impacts to undisturbed areas are in association with the new HIF in Phase 2, which will require the clearing of 0.3 acre (0.1 ha) of coastal scrub. Construction in this area is unavoidable due to HIF orientation requirements to move the assembled launch vehicle to the launch pad.

7.1 FLORIDA SCRUB-JAY

7.1.1 DIRECT IMPACTS

The clearing for the new HIF of the Proposed Action will result in the loss of approximately 0.3 acre (0.1 ha) of poor-quality unoccupied scrub-jay habitat. Figure 6-3 shows that the 2018 Florida Scrub-Jay census did not reveal the presence of any scrub-jay groups or individuals within the Proposed Action area. However, the 2018 census did observe this species within the proposed RPA Boundary area (just west of ICBM Road) but not within areas where the proposed construction would occur. As a result, direct impacts to this species are not expected. The proposed operations at SLC-20 would increase traffic in the vicinity of the scrub-jay habitat and thus create the opportunity for a take due to road-kill mortality.

7.1.2 INDIRECT IMPACTS

Potential effects to the Florida scrub-jay, if present, during construction activities would include disruption of normal activities due to noise and ground disturbances. These impacts would be short-term and would elicit a startle response to avoid the noise. This would help the birds to avoid the threat and therefore would not cause a negative impact to populations near the Proposed Action and RPA Boundary areas. Launch-related noise may startle many species within the CCAFS area. However, actual noise impact to wildlife, including the Florida scrub-jay is expected to be minimal. Current and past launch programs on CCAFS, i.e., Atlas, Titan, and Delta launches, have been documented as not causing any animal mortality or significant impact to wildlife on CCAFS (USAF, 1998).

The 45th Space Wing has a CCAFS habitat management goal of burning 500-acres annually to manage habitat for the Florida scrub-jay and other threatened and endangered species. This goal has been established through consultation with federal resource agencies pursuant to Section 7 of the Endangered Species Act. In order to achieve this goal, the 45th Space Wing typically needs 6-8 days of prescribed burning per year. Burn window opportunities for the 45th Space Wing have been periodically reduced due to numerous factors such as weather, payload transport, payload processing, payload storage at a launch pad, launches, wet dress, and static test fires, among others. Historically, the 45th Space Wing has been relatively successful at meeting this objective. However, due to the current military project needs and increasing number of commercial aerospace customers, prescribed burning has and will become more difficult.

As a result, the presence of new launch operations at SLC-20 has the potential to reduce burn windows for LMUs 15 and 18 and other LMUs due to launches, payload processing, and other operation activities. As a result, this could have negative indirect impacts on the Florida scrub-jay because of the reduced restoration of suitable habitat for this species.

Historically, the 45th Space Wing has maintained a launch table from which burn windows are identified. The increase in aerospace activities has reduced the availability of these windows due to reasons listed above as well as secondary impacts such as launch delays or improper weather conditions when a prescribed burn window arises. As a result, the 45th Space Wing plans to revise its approach with current and future users and Space Florida to ensure adequate burn windows occur annually in an effort to prioritize this listed species management activity rather than it being secondary to launch operations. The SW is currently working with senior CCAFS staff to develop operational controls that will block out a set number of days annually within which launches or other activities affected by prescribed burns cannot occur in order to allow SW to meet its habitat management goals agreed to with the resource agencies. Operational controls will be implemented that will provide more assurance that CCAFS will meet its burning goals as part of its land management unit responsibilities. In addition, Space Florida will incorporate language into their tenant lease agreements that references the 45th Space Wing prescribed burn goal, listed species management responsibilities, and resulting annual restrictions (1-2 weeks) during a 45th Space Wing predefined period. As part of the lease agreement with Space Florida, the tenants will have a contractual obligation to comply with the specified prescribed burn days schedule by providing adequate protection for their equipment (via containment or filtration systems) or moving sensitive equipment to another location while the prescribed burn days are in force. In addition, Space Florida will work closely with 45th Space Wing and attend the CCAFS Controlled Burn Working Group meetings to stay abreast of prescribed fire schedules.

Because of the potential for an indirect take of scrub-jays as noted above, the 45th Space Wing has determined that the proposed project *may affect, but not likely to adversely affect* the Florida scrub-jay.

7.2 GOPHER TORTOISE

PO gopher tortoise burrows are throughout the Proposed Action area, adjacent to proposed facilities, and very dense along the shoulders of the road that serves the SLC-20 launch pads (Figure 6-4). As such, the Proposed Action will result in the loss of occupied gopher tortoise habitat and require the relocation of numerous tortoises. Relocation activities on military bases are exempt from FFWCC permitting and fees in accordance with the FFWCC Gopher Tortoise Management Plan. Additionally, USAF is required to provide an annual report that includes relocation activities taking place on its property in accordance with the Gopher Tortoise Candidate Conservation Agreement.

All tortoises that may be impacted will be safely excavated by FFWCC-authorized gopher tortoise agents and relocated to an approved gopher tortoise recipient site on CCAFS property in accordance with FFWCC rules. The Proposed Action could result in a direct take due to mortality or injuries sustained by heavy equipment.

Reptiles and amphibians are sensitive to vibrations, which provide information about approaching predators and prey. Vibration and noise associated with construction activities would potentially cause short-term disturbance to gopher tortoises. These impacts would be considered short-term and would not cause a significant impact to populations within the vicinity of the project area. Noise associated with rocket launches may startle many species within the CCAFS area. However, actual noise impact to wildlife is expected to be minimal. As previously stated, studies on current and past launch programs on CCAFS have not been documented to cause animal mortality or significant impact to wildlife on CCAFS (USAF, 1998).

7.3 Eastern Indigo Snake

The Proposed Action will result in the loss of approximately 0.3 acre (0.1 ha) of potential eastern indigo snake habitat (undisturbed coastal scrub) and approximately 32 acres (13 ha) of disturbed habitat having a high density of gopher tortoise burrows that could be used by this species as refugia. As a result, it is unlikely a take may occur as the result of habitat loss and vast acreages of adjacent suitable habitat are present. A direct take would also not occur for this species that may be utilizing gopher tortoise burrows as all burrows will be excavated and any eastern indigo snakes will be safely moved or allowed to move outside the Proposed Action boundary. Eastern indigo snakes could be vulnerable to mortality as a result of injuries sustained during construction activities.

Reptiles and amphibians are sensitive to vibrations, which provide information about approaching predators and prey. Vibration and noise associated with construction activities would elicit a *startle response* to avoid the noise. These impacts would be considered short-term and would not cause a negative impact to the eastern indigo snake within the vicinity of the project area (USAF, Environ). Noise associated with rocket launches may startle this species within the CCAFS area. However, actual noise impact to this species is expected to be minimal. As previously stated, studies on current and past launch programs on CCAFS have not been documented to cause animal mortality or significant impact to wildlife on CCAFS (USAF, 1998).

Due to the potential for indirect take of the eastern indigo snake as noted above, the 45th Space Wing has determined that the proposed project *may affect, but not likely to adversely affect* the eastern indigo snake.

7.4 Southeastern Beach Mouse

Construction and operations will occur approximately 100 feet west of the beach dune area, typical habitat of the beach mouse. However, the Proposed Action will not result in the clearing of beach dune habitat and is limited to clearing 0.3 acre (0.1 ha) of coastal scrub approximately 850 feet west of the toe-of-slope of coastal dune habitat. All other impacts will be to previously disturbed and maintained low-quality ruderal habitat associated with the legacy SLC-20 area.

This species has been documented in the blockhouse, which will be renovated under the Proposed Action. As such, a take of beach mice is not expected to occur due to a loss of potential habitat. Rather, a take may occur as a result of the renovation of abandoned facilities that this species is known to use as refugia. However, the SLC-20 tenant will

request and perform live trapping in accordance with the USFWS August 2002 BO on rodent trapping.

Potential noise-related effects to the southeastern beach mouse during construction activities would include disruption of normal activities due to noise and ground disturbances. These impacts would be short-term and would elicit a startle response to avoid the noise. This would help the mice avoid the threat and therefore would not cause an impact to this species within the vicinity of the project area. Noise associated with rocket launches may startle this species within the CCAFS area. However, actual noise impact to this species is expected to be minimal. As previously stated, studies on current and past launch programs on CCAFS have not documented animal mortality or significant impact to wildlife on CCAFS (USAF, 1998).

The proposed operations at SLC-20 would increase traffic in the vicinity of the southeastern beach mouse habitat and thus create the opportunity for a take due to road-kill mortality.

Due to the potential for direct and indirect take of the southeastern beach mouse as noted above, the 45th Space Wing has determined that the proposed project *may affect and is likely to adversely affect* the southeastern beach mouse.

7.5 Marine Turtles

The proposed clearing and construction of new facilities would not directly impact the nesting beach. Exterior lighting proposed for the new facilities and lighting required for night launches has the potential to be visible from the beach and could result in adult and/or hatchling disorientation adjacent to SLC-20. However, proposed lighting and its use will be outlined in a CCAFS-approved LMP.

Sea turtles are not expected to be affected by vibration and noise associated with construction activities since the project area will be beyond the beach and dune area. However, noise associated with rocket launches may startle many species within the CCAFS area, but the noise impact to wildlife is expected to be minimal. Sonic boom noise in the area is minimal, and large sonic boom may only occur offshore and would also have no effect.

Due to the potential that night launches may result in the disorientation of hatchlings, the 45th Space Wing has determined that the proposed project *may affect and is likely to adversely affect* the five species of marine turtles occurring at CCAS.

7.6 West Indian Manatee

The Proposed Action contains no habitat for this species and their presence is limited to Atlantic Ocean coastal waters to the east. Manatees are not expected to be affected by vibration and noise associated with construction activities since they are not in the area.

Noise associated with rocket launches may startle many species within the CCAFS area; however, its impact to wildlife is expected to be minimal. Sonic boom noise impacts to this species is expected to be negligible since it will occur many miles offshore.

Due to the lack of habitat, the 45th Space Wing has determined that the proposed project will have *no effect* on the West Indian manatee.

7.7 American Alligator

The Proposed Action will not impact the American alligator or its habitat as the small man-made swale totaling 0.19 acre (0.08 ha) would not be considered alligator habitat. Therefore, the Proposed Action is not likely to impact alligators. The RPA Boundary area does contain two cattail ponds that could provide habitat for this species. However, the Proposed Action proposes no impacts to this habitat.

Reptiles and amphibians are sensitive to vibrations, which provide information about approaching predators and prey. Vibration and noise associated with construction activities could cause short-term disturbance to an alligator. These impacts would be considered short-term and would not affect alligators within the vicinity of the project area. Noise associated with rocket launches may startle the American alligator and other species within the CCAFS area. However, actual noise impact to wildlife is expected to be minimal. As previously stated, studies on current and past launch programs on CCAFS have not been documented to cause animal mortality or significant impact to wildlife on CCAFS (USAF, 1998).

Because of the lack of potential impact to this species, the 45th Space Wing has determined that the proposed project will have *no effect* on the American alligator.

7.8 American Wood Stork

The Proposed Action area does not contain wetland or surface waters that would be used by the American wood stork. However, the proposed RPA Boundary area does contain two cattail dominated ponds comprising 2.5 acres (1.0 ha) that could provide marginal foraging habitat. The dense vegetation limits the value of this habitat for the wood stork. Approximately 15.5 acres (6.3 ha) of shallow depressional wetlands exist characterized as wet prairies throughout the RPA Boundary area. However, as previously mentioned, these wetlands do not experience prolonged inundation and they are not connected to other wetlands or surface waters to support fish species that wood storks rely on. As such, these wetlands likely provide little to no foraging habitat for use by the American wood stork.

Noise associated with rocket launches may startle many species within the CCAFS area. Actual noise impact to wildlife is expected to be minimal. As previously stated, studies on current and past launch programs on CCAFS have not been documented to cause animal mortality or significant impact to wildlife on CCAFS (USAF, 1998). Sonic boom noise may only occur well offshore and its impact on this species is expected to be minimal.

Due to the lack of potential impact to this species, the 45th Space Wing has determined that the proposed project *may affect but is not likely to adversely affect* the American wood stork.

7.9 Piping Plover

The piping plover forages along the shoreline and nesting has been documented in Brevard County. As a result, the Proposed Action and future activities within the RPA Boundary area will not impact Piping Plover habitat.

Potential noise-related effects from construction or launches is not expected to impact the piping plover.

Due to the lack of potential impact to this species, the 45th Space Wing has determined that the proposed project *may affect but is not likely to adversely affect* the piping plover.

7.10 RED KNOT

The red knot is recognized as an occasional visitor that forages along the shoreline during its migration. The Proposed Action or future activities within the RPA Boundary area will not impact shoreline habitat used by the red knot.

Potential noise-related effects from construction or launches is not expected to impact the red knot.

Due to the lack of potential impact to this species, the 45th Space Wing has determined that the proposed project *may affect but is not likely to adversely affect* the red knot.

8 COMPENSATION FOR AFFECTED SPECIES

8.1 FLORIDA SCRUB-JAY

USFWS and USAF have agreed to a mitigation formula for scrub-jay habitat impacts that mitigate loss of scrub or potential scrub habitat acreage by restoring degraded scrub habitat at a 2:1 ratio. The objective of CCAFS scrub habitat restoration is to restore, using fire and mechanical methods, the over-mature scrub to a condition suitable to support the Florida scrub-jay. The 45th Space Wing proposes to enhance coastal scrub habitat on the southeast corner of SLC-19 as compensation for effects on the southeastern beach mouse (Figure 8-1). This habitat enhancement will provide suitable habitat for the Florida scrub-jay to mitigate the proposed 0.3 acre of habitat impacts. Space Florida will be the agency responsible for the completion and subsequent monitoring of the habitat enhancement mitigation area.

Although the Proposed Action area is not suitable habitat nor currently occupied, scrub-jay surveying would be conducted before clearing to ensure that no jays are nesting within 300 feet of clearing activities. All suitable scrub-jay habitat would be surveyed for nesting jays. Any nests encountered would be flagged and no clearing would be allowed within 300 feet until all birds have fledged.

8.2 GOPHER TORTOISE

Substantial impacts to gopher tortoises could occur due to the high density of this species within the Proposed Action area. A high density of gopher tortoise burrows occurs on the shoulders of the launch pad access roads as well as the north/south road spur that ends at the launch pad (Figure 6-4). These roads are very old and need repairing and at a minimum resurfacing. Currently, the extent of road renovations or expansion under the Proposed Action have not been determined; therefore, the resulting impacts to the gopher tortoise is not known.

To minimize impacts to gopher tortoises, gopher tortoise burrows will not be disturbed if a minimum of a 25-foot (7.6-m) buffer can remain as well as maintaining connectivity of this buffer to foraging areas in accordance with FFWCC guidelines. No more than 90 days before and no fewer than 72 hours before any clearing or construction, a 100-percent pedestrian survey in accordance with FFWCC guidelines will be conducted to locate and flag/stake all burrows. Gopher tortoise burrows that occur within areas to be cleared, areas for new construction, or burrows found on the shoulder of roads to be rebuilt will be excavated, and captured tortoises will be relocated by an FFWCC-authorized agent in accordance with FFWCC guidelines to the 45th Space Wing-approved recipient site on CCAFS. A map showing the locations of the burrow and their occupancy status if a tortoise was captured will be provided to the construction contractor by the commercial space entity under lease agreement with Space Florida for SLC-20. Educational posters will be provided to construction personnel and future tenant personnel so that they are observant for any tortoises that may enter the construction site or during site operations. Any live or dead tortoises observed will be reported to the 45th Space Wing immediately.

Figure 8-1 Proposed Habitat Enhancement Location Map

8.3 Eastern Indigo Snake

The 45th Space Wing Indigo Snake Protection/Education Plan will be presented to the commercial space user project manager, their construction manager, and construction personnel. Educational signs will be displayed at the site to inform personnel of the snake's appearance, its protected status, and who to contact if any are spotted in the area. If any indigo snakes are encountered during clearing activities, they will be allowed to safely move out of the project area. Any observations of live or dead indigo snakes will be reported to the 45th Space Wing immediately, who will then report it to USFWS if appropriate.

8.4 Southeastern Beach Mouse

The Proposed Action would not significantly impact the southeastern beach mouse population at CCAFS since no clearing or construction of suitable habitat will occur. However, there could be a take of a southeastern beach mouse due to their use of the block house and disturbed habitats between this structure and the coast dunes. USAF has an USFWS Programmatic Biological Opinion that addresses impacts to beach mice associated with certain activities including launch site restoration actions (USFWS, 2002). Based on past studies completed for CCAFS, beach mice are benefitting from the same land management activities being conducted for scrub-jays, and the population is expanding into inland locations. However, as compensation for the potential take of this species as a result of the Proposed Action, Space Florida is proposing to enhance dune and coastal scrub habitat within an area on the southeast corner of SLC-19 (Figure 8-1). This habitat enhancement will help to provide high quality habitat and a corridor to additional suitable interior habitat. Space Florida will be the agency responsible for the completion and subsequent monitoring of the habitat enhancement mitigation area.

8.5 Marine Turtles

To minimize potential impacts to sea turtles from new or temporary facility lighting, the majority of exterior lighting proposed for this project would be in accordance with the 2018 45th SWI 32-7001, *Exterior Lighting Management*. Some *non-turtle friendly* lighting may be required during the day of launch and if any launches were occurring at night. An LMP will be completed by the SLC-20 tenant and submitted to the 45th Space Wing and USFWS for approval before new or temporary lighting construction. Clearing of vegetation at the SLC-20 area will not have an impact to nesting or hatchling sea turtles; therefore, no mitigation is required for those activities.

8.6 West Indian Manatee

Since the area where the West Indian manatee may be present is offshore well to the east of the Proposed Action area, negligible impacts are expected; therefore, mitigation measures are not proposed or needed.

8.7 American Alligator

Since the only potential water bodies where alligators may reside are not part of the Proposed Action construction area, impacts to this species are not expected; therefore, no mitigation measures are needed. However, construction and operations personnel will be advised of the potential presence of alligators in the off-site cattail ponds and disturbance

to nests is not authorized. Additionally, Space Florida and its lessee will be responsible for ensuring all personnel understand the laws regarding the feeding of alligators. Any personnel observed feeding alligators will be reported to the appropriate authorities.

8.8 American Wood Stork

This species or its nests have not been observed on-site. In addition, no suitable foraging habitat exists within the Proposed Action Boundary. Therefore, no mitigation measures are required or proposed. During launch operations, wood storks in surrounding areas could be startled but this is expected to be a short-term impact.

8.9 Piping Plover

Since no clearing or disturbance to the beach is proposed, impacts to piping plover habitat will not occur. However, during launch operations, any plovers on the beach adjacent to SLC-20 could be startled; this would be expected to be a short-term impact.

8.10 Red Knot

Since no clearing or disturbance to the beach is proposed, impacts to red knot habitat will not occur. However, during launch operations, red knots on the beach adjacent to SLC-20 could be startled; this would be expected to be a short-term impact.

9 CUMULATIVE IMPACTS

Potential cumulative adverse impacts would occur for the Florida scrub-jay and eastern indigo snake when evaluated with other projects occurring or proposed on CCAFS and the potential for additional coastal scrub impacts in the future within the RPA Boundary area. These potential cumulative impacts arise due to the removal of coastal scrub habitat that could support the eastern indigo snake and coastal scrub habitat that could be restored in the future to support additional Florida scrub-jays. Potential cumulative impacts could also occur as a result of additional launches by future tenants, which could negatively affect the CCAFS controlled burn program, thereby slowing Florida scrub-jay habitat restoration efforts.

Cumulative impacts on the gopher tortoise are not expected within the Proposed Action area or the RPA Boundary area. Gopher tortoises observed within any area to be impacted by ground disturbance would be excavated and relocated by an FFWCC-Authorized Agent to an onsite recipient area approved and managed by USAF.

Cumulative impacts on sea turtles have the potential to occur. The new facilities will result in more exterior lighting than is currently present at LC-20. Adherence to the LMP and USAF lighting policies will minimize these impacts. CCAFS- and FFWCC-compliant lighting will be used to minimize potential adverse impacts on nesting turtles and/or their young.

Cumulative impacts on the West Indian manatee, American alligator, American wood stork, piping plover, and red knot are not expected to occur with the Proposed Action as there is no habitat that supports these species in the Proposed Action Boundary area. In addition, cumulative impacts on these species is not expected in the RPA Boundary area due to the lack of habitat to support these species.

10 LIST OF PREPARERS

- B.J. Bukata, MS, PWS, AA, Senior Scientist and Authorized Gopher Tortoise Agent, Jones Edmunds.
- Laura Coveney Craig, AA, Project Scientist and Authorized Gopher Tortoise Agent, Jones Edmunds.
- Nicola Staton, Senior Technical Communications Coordinator, Jones Edmunds.
- Nancy Vaseen, Senior Technical Communications Coordinator, Jones Edmunds.
- Stephen Berry, Vice President of Operations, LG2 Environmental Solutions, Inc.
- Priyanka Valletta, PE, Civil Engineer, BRPH Architects-Engineers, Inc.

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APPENDIX E

NMFS Consultation

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
http://sero.nmfs.noaa.gov

F/SER31: NMB

Donald Dankert
Environmental Management Branch
National Aeronautics and Space Administration
John F. Kennedy Space Center
Mail Code: SI-E3
Kennedy Space Center, Florida 32899

AUG 0 8 2016

Daniel Czelusniak
Environmental Specialist
Federal Aviation Administration
800 Independence Avenue Southwest
Suite 325
Washington, DC 20591

Dear Mr. Dankert and Mr. Czelusniak:

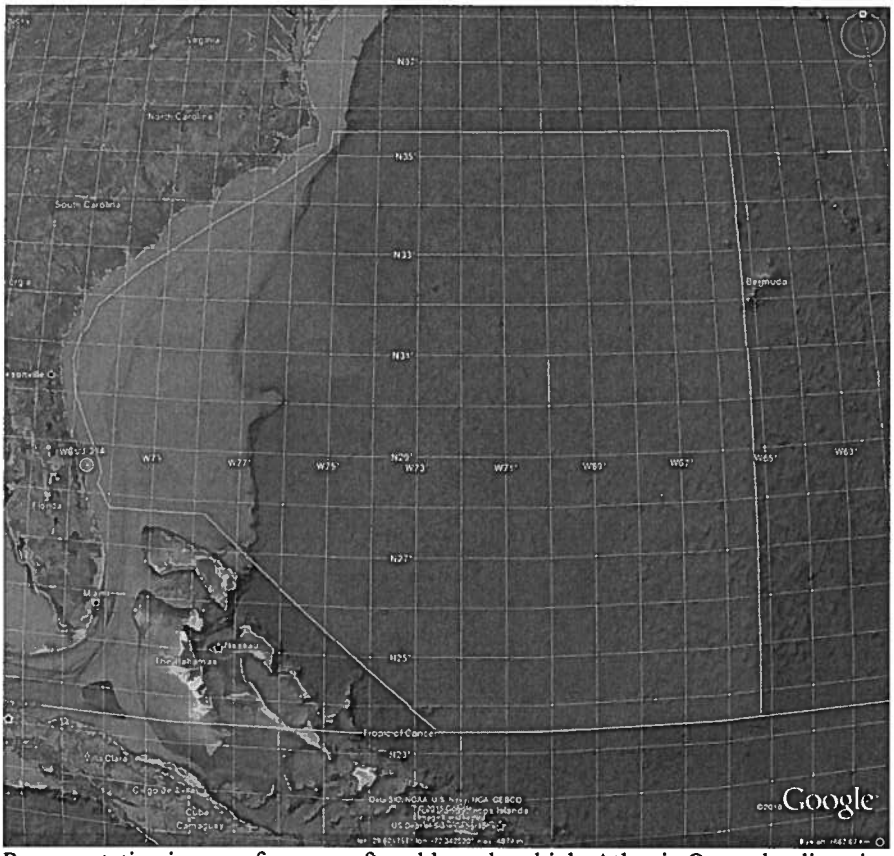
This letter responds to your request for consultation with us, the National Marine Fisheries Service (NMFS), pursuant to Section 7 of the Endangered Species Act (ESA) for the following action.

Applicant(s)	SER Number	Project Type(s)
National Aeronautics and Space Administration (NASA) and Federal Aviation Administration	SER-2016-17894	Waterborne landings of spacecraft

Consultation History
We received your letter requesting consultation on April 11, 2016. We discussed the project with the applicant on May 3, 2016, and requested additional information. During this call, we determined that the project would be expanded from the request to analyze 2 launches with NASA as the lead federal agency to now analyzing all launches occurring from the Kennedy Space Center (KSC), Cape Canaveral Air Force Station (CCAFS), and SpaceX Texas Launch Complex, with the lead federal agency being assigned as NASA, Federal Aviation Administration, or the U.S. Air Force. After exchanging 3 drafts of the project description, we received a final response on July 14, 2016, and initiated consultation that day.

Project Location

Address	Latitude/Longitude	Water body
Kennedy Space Center and Canaveral Air Force Station, Brevard County, Florida	28.608402°N, 80.604201°W (North American Datum 1983) Coordinates provided are for launch pad 39A. Other launch pads at the KSC and CCAFS may be used.	Atlantic Ocean off of Cape Canaveral and Gulf of Mexico
Texas SpaceX Launch Site, 2 miles east of Boca Chica Village, Cameron County, Texas	25.99684°N, 97.15523°W (World Geodetic System 1984)	Gulf of Mexico



Representative image of spacecraft and launch vehicle Atlantic Ocean landing site (Image provided by NASA)

Representative image of spacecraft and launch vehicle Gulf of Mexico landing site (Image provided by NASA)

Existing Site Conditions

The KSC and CCAFS are located on Merritt Island on the northeast coast of Florida. The Texas SpaceX launch site is located on a private site along the east coast of Texas away from the nearby beach. All launch areas are located in upland areas and landing areas are located in open-water within the Atlantic Ocean or Gulf of Mexico, as shown in the images above. The open-water areas for planned landings start a minimum of 5 nautical miles offshore and exclude North Atlantic right whale critical habitat in the Atlantic Ocean.

Project Description

For the purposes of this consultation, the term "spacecraft" will be used to describe modules sent into orbit on the launch vehicle carrying payloads, supplies, or crew. The term "launch vehicle" will be used to describe the rocket and all of its components.

The launch complexes on KSC and CCAFS provide the capability for a variety of vertical and horizontal launch vehicles including, but not limited to, Atlas V, Delta IV, Delta IV Heavy, Liberty, Falcon 9 and 9 v1.1, Falcon Heavy, Antares, RSLV-S, Athena IIc, Xaero, and the Space Launch System to be processed and launched. These launch vehicles and their commercial or government operators are responsible for transporting various spacecraft and payloads into orbit, including reusable manned and unmanned spacecraft such as Orion, Dream Chaser, Boeing CST-100, Liberty Composite Crew Module, and the SpaceX Crew and Cargo Dragon.

The SpaceX Texas launch site provides the capability for operating the Falcon 9 and Falcon Heavy launch vehicles. All Falcon 9 and Falcon Heavy launches would be expected to have payloads including satellites or experimental payloads. Additionally, the Falcon 9 and Falcon Heavy may also carry the SpaceX Dragon spacecraft. Most payloads would be commercial; however, some could be government sponsored launches.

Commercial and government spacecraft launched from KSC, CCAFS and the SpaceX Texas launch complex may result in portions of the spacecraft and/or launch vehicle returning to earth and landing in the Atlantic Ocean or Gulf of Mexico. The launch trajectories are specific to each particular launch vehicle's mission. However, all launches are conducted to the east over the

Atlantic Ocean, similar to past and current launches from KSC and CCAFS. All launch trajectories from the SpaceX Texas launch facility would be to the east over the Gulf of Mexico.

The following is a representative example of a nominal launch, waterborne landing and recovery based on the SpaceX Falcon 9 launch vehicle and the Crew Dragon spacecraft launched from KSC. This scenario is also generally applicable to other launch vehicles and spacecraft launch and recovery operations. It should be noted that currently not all of the above mentioned launch vehicles have a recoverable first or second stage. For example, launch vehicles in the Atlas and Delta family are classified as evolved expendable launch vehicles. These types of launch vehicles destruct upon reentry into the atmosphere and are not recovered. In the unlikely event of a launch failure, pad abort, or assent abort, efforts would be made to attempt to recover any remaining portions of the launch vehicle or spacecraft. Any debris that could not be recovered from the surface would sink to the ocean bottom.

There are several scenarios that could occur due to a launch failure:

- The entire launch vehicle and spacecraft, with onboard propellants, fails on the launch pad and an explosion occurs. The spacecraft may be jettisoned into the nearshore waters.
- The entire launch vehicle and spacecraft, with onboard propellants, is consumed in a destruction action during assent. The launch vehicle is largely consumed in the destruction action and the spacecraft is jettisoned, but residual propellant escapes and vaporizes into an airborne cloud.
- The launch vehicle and spacecraft survive to strike the water intact or partially intact potentially releasing propellants into the surface waters.

The probability of any of these launch failure scenarios is unknown and highly unlikely but could potentially have a short term localized adverse effect on marine life and habitat. To date, NASA has had a 98-99% success rate with launches.

Following the nominal launch of the launch vehicle and following first stage separation the launch vehicle would make a powered decent returning to either a designated landing pad located onshore or a drone ship located approximately 500 miles down range on the Atlantic Ocean east of Cape Canaveral or in the Gulf of Mexico. The manned or unmanned spacecraft, after completion of its mission, would descend into the Atlantic Ocean or Gulf of Mexico either under parachute canopy or propulsive landing. These capsules are relatively small in size, averaging less than 200 square feet (ft^2) in size. The main parachutes may be up to 150 feet (ft) in diameter.

A propulsive landing scenario and parachute landing scenario generally follow the same landing sequence with the main difference being that under a propulsive landing scenario the spacecraft would fire its engines to slow its decent. The spacecraft performs a deorbit burn in orbit and re-enters the atmosphere on a lifting guided trajectory. At high altitudes, the vehicle may perform an "engine burp" in order to test engine health before the propulsive landing. For a propulsive landing, the drogue chutes may be used but the main parachutes will not be deployed. Instead, at an altitude of between approximately 500 and 1,000 meters, the vehicle will light its engines and start to decelerate until ultimately it makes a waterborne landing. In a non-propulsive

waterborne landing scenario the main parachutes are deployed at a predesignated altitude and slow the spacecraft to a safe speed prior to entering the water.

Following a successful landing, a contracted vessel will retrieve the parachutes and spacecraft from the water surface. Since the contracted vessel will be in the water to observe the test, recovery of the capsule and parachutes is expected to begin within an hour of the landing. The vessel will either use an overhead crane to load the capsule onto the vessel or tow the capsule back to shore at Port Canaveral or other nearby commercial wharf where it will be offloaded and transported to an inland facility.

A spacecraft reentering the atmosphere for either a propulsive or non-propulsive waterborne landing may contain residual amounts of propellant used to support on-orbit operations, the deorbit burn, entry and attitude control and propulsive landings. Spacecraft are designed to contain residual propellant and it is not expected that there would be a release of any propellants into the water. Once the spacecraft is safely transported back to land the remaining propellants would be offloaded.

In the unlikely event that any propellants are released into the water during a failed launch or a water landing, they would be quickly dispersed and diluted and would not be expected to create any long term effects on habitat or species within proximity to the landing area. According to NASA, spacecraft may carry hypergolic propellants, which are toxic to marine organisms. Specifically, the spacecraft may carry nominal values of monomethylhydrazine fuel and nitrogen tetroxide oxidizer. Propellant storage is designed to retain residual propellant, so any propellant remaining in is not expected to be released into the ocean. Nitrogen tetroxide almost immediately forms nitric and nitrous acid on contact with water, and would be very quickly diluted and buffered by seawater; hence, it would offer negligible potential for harm to marine life. With regard to hydrazine fuels, these highly reactive species quickly oxidize forming amines and amino acids. Prior to oxidation, there is some potential for exposure of marine life to toxic levels, but for a very limited area and time. A half-life of 14 days for hydrazine in water is suggested based on the unacclimated aqueous biodegradation half-life.

Within the overall missions that could potentially have waterborne landings there may be a limited number of pad abort and assent abort testing operations that would involve launching spacecraft on a low altitude non-orbit trajectory resulting in a waterborne landing within 1-20 miles east of the launch site in the coastal waters of the Atlantic Ocean. This type of testing operation would typically involve a non-propulsive landing using both drogue and main parachutes. Recovery operations would be consistent with the description above.

As the space program advances, there is currently a general progression in the development of technology and mission operations to enable both launch vehicles and spacecraft to land on barges at sea and ultimately on land. To that end, the need for open-water landings of routine missions may be phased out in the future. However, it is likely that waterborne landings in the Atlantic Ocean or Gulf of Mexico will be utilized as back-up landing locations to land based landing sites. NASA estimates that approximately 60 open-water landings could occur in the next 10 years including test launches associated with pad abort and ascent abort operations. Open-water landings may occur day or night at any time of year. This consultation address all

open-water landings occurring from KSC, CCAFS and the SpaceX Texas Launch Complex result in portions that follow the protective measures defined below.

Construction Conditions

NASA will follow the protective measures listed below:

1) **Education and Observation**: All personnel associated with the project shall be instructed about the presence of species protected under the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA).
   a) A dedicated observer shall be responsible for monitoring for ESA-species during all in-water activities including transiting marine waters to retrieve space launch equipment. Observers shall survey the area where space equipment landed in the water to determine if any ESA-listed species were injured or killed.
   b) All personnel shall be advised that there are civil and criminal penalties for harming, harassing, or killing ESA listed species or marine mammals.
   c) More information about ESA-listed species is available on our website at: http://sero.nmfs.noaa.gov/protected_resources/section_7/threatened_endangered/index.html

2) **Reporting** of interactions with protected species:
   a) Any collision(s) with and/or injury to any sea turtle, sawfish, or whale, shall be reported immediately to NMFS's Protected Resources Division (PRD) at (1-727-824-5312) or by email to takereport.nmfsser@noaa.gov.
   b) Smalltooth sawfish: Report sightings to 1-941-255-7403 or email Sawfish@MyFWC.com
   c) Sea turtles and marine mammals: Report stranded, injured, or dead animals to 1-877-WHALE HELP (1-877-942-5343).
   d) North Atlantic right whale: Report injured, dead, or entangled right whales to the U.S. Coast Guard via VHF Channel 16.

3) **Vessel Traffic and Construction Equipment**: All vessel operators must watch for and avoid collision with ESA-protected species. Vessel Operators must maintain a safe distance by following these protective measures:
   a) Sea turtles: Maintain a minimum distance of 150 ft.
   b) North Atlantic right whale: Maintain a minimum 1,500 ft (500 yard) distance.
   c) Vessels 65-ft long or more must comply with the Right Whale Ship Strike Reduction Rule (50 CFR 224.105) including reducing speeds to 10 knots or less in Seasonal Management Areas (http://www.fisheries.noaa.gov/pr/shipstrike/).
   d) Mariners shall check various communication media for general information regarding avoiding ship strikes and specific information regarding right whale sightings in the area. These include NOAA weather radio, U.S. Coast Guard NAVTEX broadcasts, and Notices to Mariners.
   e) Marine mammals (i.e., dolphins, whales, and porpoises): Maintain a minimum distance of 300 ft.
   f) When these animals are sighted while the vessel is underway (e.g., bow-riding), attempt to remain parallel to the animal's course. Avoid excessive speed or abrupt changes in direction until they have left the area.

g) Reduce speed to 10 knots or less when mother/calf pairs or groups of marine mammals are observed, when safety permits.

4) **Hazardous Materials Emergency Response**: In the unlikely event of a failed launch or landing, SpaceX would follow the emergency response and cleanup procedures outlined in their Hazardous Material Emergency Response Plan. These procedures may include containing the spill using disposable containment materials and cleaning the area with absorbents or other materials to reduce the magnitude and duration of any impacts. In most launch failure scenarios at least a portion of the fuels will be consumed by the launch, and any remaining fuels will be diluted by seawater and biodegrade over time (timeframes are variable based on environmental conditions).

Effects Determination(s) for Species the Action Agency or NMFS Believes May Be Affected by the Proposed Action

Species	ESA Listing Status	Action Agency Effect Determination	NMFS Effect Determination
Sea Turtles			
Green (North Atlantic and South Atlantic distinct population segment [DPS])	T	NLAA	NLAA
Kemp's ridley	E	NLAA	NLAA
Leatherback	E	NLAA	NLAA
Loggerhead (Northwest Atlantic Ocean DPS)	T	NLAA	NLAA
Hawksbill	E	NLAA	NLAA
Fish			
Smalltooth sawfish (U.S. DPS)	E	NLAA	NLAA
Gulf sturgeon (Atlantic sturgeon, Gulf subspecies)	T	NLAA	NLAA
Shortnose sturgeon	E	NLAA	NLAA
Atlantic sturgeon (Carolina DPS)	E	NLAA	NLAA
Atlantic sturgeon (South Atlantic DPS)	E	NLAA	NLAA
Marine Mammals			
North Atlantic right whale	E	NLAA	NLAA
Blue whale	E	ND	NLAA
Fin whale	E	ND	NLAA
Humpback whale	E	ND	NLAA
Sei whale	E	ND	NLAA
Sperm whale	E	ND	NLAA
E = endangered; T = threatened; NLAA = may affect, not likely to adversely affect; ND = no determination			

Critical Habitat

North Atlantic right whale critical habitat

NASA planned landings are proposed to occur outside of North Atlantic right whale critical habitat. In the unlikely event that a launch failure occurred in nearshore waters near Cape Canaveral, it could occur in North Atlantic right whale critical habitat. The following essential features are present in Unit 2:

- Sea surface conditions associated with Force 4 or less on the Beaufort Scale
- Sea surface temperatures of 7°C to 17°C
- Water depths of 6 to 28 m, where these features simultaneously co-occur over contiguous areas of at least 231 square nautical miles of ocean waters during the months of November through April. When these features are available, they are selected by right whale cows and calves in dynamic combinations that are suitable for calving, nursing, and rearing, and which vary, within the ranges specified, depending on factors such as weather and age of the calves.

We do not believe any of the essential features may be affected by the proposed action.

Loggerhead sea turtle critical habitat

The in-water landing sites are located within the boundary of loggerhead sea turtle critical habitat. The following primary constituent elements (PCEs) are present in the Atlantic Ocean and Gulf of Mexico landing areas that include Units Logg-N-1 to Logg-N-19 plus Logg-S-1 and Logg-S-2. Since the open-water landing areas begin 5 nautical miles offshore, nearshore reproductive habitat is not considered within the planned landing areas. In the unlikely event that a launch failure occurred in nearshore waters near Cape Canaveral, it could occur in loggerhead nearshore reproductive critical habitat.

- Nearshore reproductive habitat: The physical or biological features of nearshore reproductive habitat as a portion of the nearshore waters adjacent to nesting beaches that are used by hatchlings to egress to the open-water environment as well as by nesting females to transit between beach and open water during the nesting season. The following primary constituent elements support this habitat: (i) Nearshore waters directly off the highest density nesting beaches and their adjacent beaches, as identified in 50 CFR 17.95(c), to 1.6 kilometers offshore; (ii) Waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water; and (iii) Waters with minimal manmade structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures), disrupt wave patterns necessary for orientation, and/or create excessive longshore currents.
- Breeding areas: the physical or biological features of concentrated breeding habitat as those sites with high densities of both male and female adult individuals during the breeding season. Primary constituent elements that support this habitat are the following: (i) High densities of reproductive male and female loggerheads; (ii) Proximity to primary Florida migratory corridor; and (iii) Proximity to Florida nesting grounds.
- Constricted migratory habitat: the physical or biological features of constricted migratory habitat as high use migratory corridors that are constricted (limited in width) by land on one side and the edge of the continental shelf and Gulf Stream on the other side. Primary

constituent elements that support this habitat are the following: (i) Constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways; and (ii) Passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas.

- Sargassum habitat: the physical or biological features of loggerhead *Sargassum* habitat as developmental and foraging habitat for young loggerheads where surface waters form accumulations of floating material, especially *Sargassum.* Primary constituent elements that support this habitat are the following: (i) Convergence zones, surface-water downwelling areas, the margins of major boundary currents (Gulf Stream), and other locations where there are concentrated components of the *Sargassum* community in water temperatures suitable for the optimal growth of *Sargassum* and inhabitance of loggerheads; (ii) *Sargassum* in concentrations that support adequate prey abundance and cover; (iii) Available prey and other material associated with *Sargassum* habitat including, but not limited to, plants and cyanobacteria and animals native to the *Sargassum* community such as hydroids and copepods; and (iv) Sufficient water depth and proximity to available currents to ensure offshore transport (out of the surf zone), and foraging and cover requirements by *Sargassum* for post-hatchling loggerheads, i.e., >10 m depth.
- Winter habitat: the physical or biological features of loggerhead winter habitat are warm water habitat south of Cape Hatteras near the western edge of the Gulf Stream used by a high concentration of juveniles and adults during the winter months. Primary constituent elements that support this habitat are the following: (i) Water temperatures above 10° C from November through April; (ii) Continental shelf waters in proximity to the western boundary of the Gulf Stream; and (iii) Water depths between 20 and 100 m.

We do not believe any of the PCEs may be affected by the proposed action.

Analysis of Potential Routes of Effects to Species

Sea turtles, smalltooth sawfish, sturgeon, whales may be affected by open-water landings if they were to be struck by falling materials, spacecraft, or controlled burn water landings. Due to the relative small size of capsules (less than 200 ft^2), NMFS believes that is highly unlikely that protected species will be struck and that the effects are discountable. Smalltooth sawfish and sturgeon are bottom dwelling and unlikely to interact with these items at the surface. Sea turtles and whales spend time at the surface to breath and are thus are at a higher risk of interacting with spacecraft. However, turtles and whales spend the majority of their time submerged as opposed to on the surface, thus lowering the risk of interactions. These launches have been occurring for decades with no known interactions with sea turtles or whales. Also, launches occur intermittently (occurring approximately every few months) and the goal is to ultimately reduce and eliminate the need for open-water landings.

Sea turtles and whales could also become entangled in the parachutes that will transport the capsule to the water surface. However, we believe that these species will avoid the area immediately following a landing and that all materials will be retrieved quickly (approximately 1 hour). Therefore, we believe the risk of entanglement is discountable.

Sea turtles, smalltooth sawfish, sturgeon, and whales could be affected by any hazardous materials spilled into the Atlantic Ocean or Gulf of Mexico during the proposed action.

However, such an effect is highly unlikely (98-99% success rate), failed missions do not necessarily occur over marine waters, and most if not all fuel would be consumed or contained. For planned marine landings, all fuel valves will shut automatically prior to landing to retain any residual fuels. Therefore, although a small fuel spill is possible, it is highly unlikely and any risk to protected species is discountable.

Conclusion

Because all potential project effects to listed species and critical habitat were found to be discountable, insignificant, or beneficial, we conclude that the proposed action is not likely to adversely affect listed species and critical habitat under NMFS's purview. This concludes your consultation responsibilities under the ESA for species under NMFS's purview. Consultation must be reinitiated if a take occurs or new information reveals effects of the action not previously considered, or if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat in a manner or to an extent not previously considered, or if a new species is listed or critical habitat designated that may be affected by the identified action. NMFS's findings on the project's potential effects are based on the project description in this response. Any changes to the proposed action may negate the findings of this consultation and may require reinitiation of consultation with NMFS.

We have enclosed additional relevant information for your review. We look forward to further cooperation with you on other projects to ensure the conservation of our threatened and endangered marine species and designated critical habitat. If you have any questions on this consultation, please contact Nicole Bonine, Consultation Biologist, at (727) 824-5336, or by email at Nicole.Bonine@noaa.gov.

Sincerely,

for Roy E. Crabtree, Ph.D.
Regional Administrator

Enc.: 1. *Sea Turtle and Smalltooth Sawfish Construction Conditions* (Revised March 23, 2006)
2. *PCTS Access and Additional Considerations for ESA Section 7 Consultations* (Revised March 10, 2015)

File: 1514-22.V

SEA TURTLE AND SMALLTOOTH SAWFISH CONSTRUCTION CONDITIONS

The permittee shall comply with the following protected species construction conditions:

a. The permittee shall instruct all personnel associated with the project of the potential presence of these species and the need to avoid collisions with sea turtles and smalltooth sawfish. All construction personnel are responsible for observing water-related activities for the presence of these species.

b. The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles or smalltooth sawfish, which are protected under the Endangered Species Act of 1973.

c. Siltation barriers shall be made of material in which a sea turtle or smalltooth sawfish cannot become entangled, be properly secured, and be regularly monitored to avoid protected species entrapment. Barriers may not block sea turtle or smalltooth sawfish entry to or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service's Protected Resources Division, St. Petersburg, Florida.

d. All vessels associated with the construction project shall operate at "no wake/idle" speeds at all times while in the construction area and while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.

e. If a sea turtle or smalltooth sawfish is seen within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a sea turtle or smalltooth sawfish. Operation of any mechanical construction equipment shall cease immediately if a sea turtle or smalltooth sawfish is seen within a 50-ft radius of the equipment. Activities may not resume until the protected species has departed the project area of its own volition.

f. Any collision with and/or injury to a sea turtle or smalltooth sawfish shall be reported immediately to the National Marine Fisheries Service's Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization.

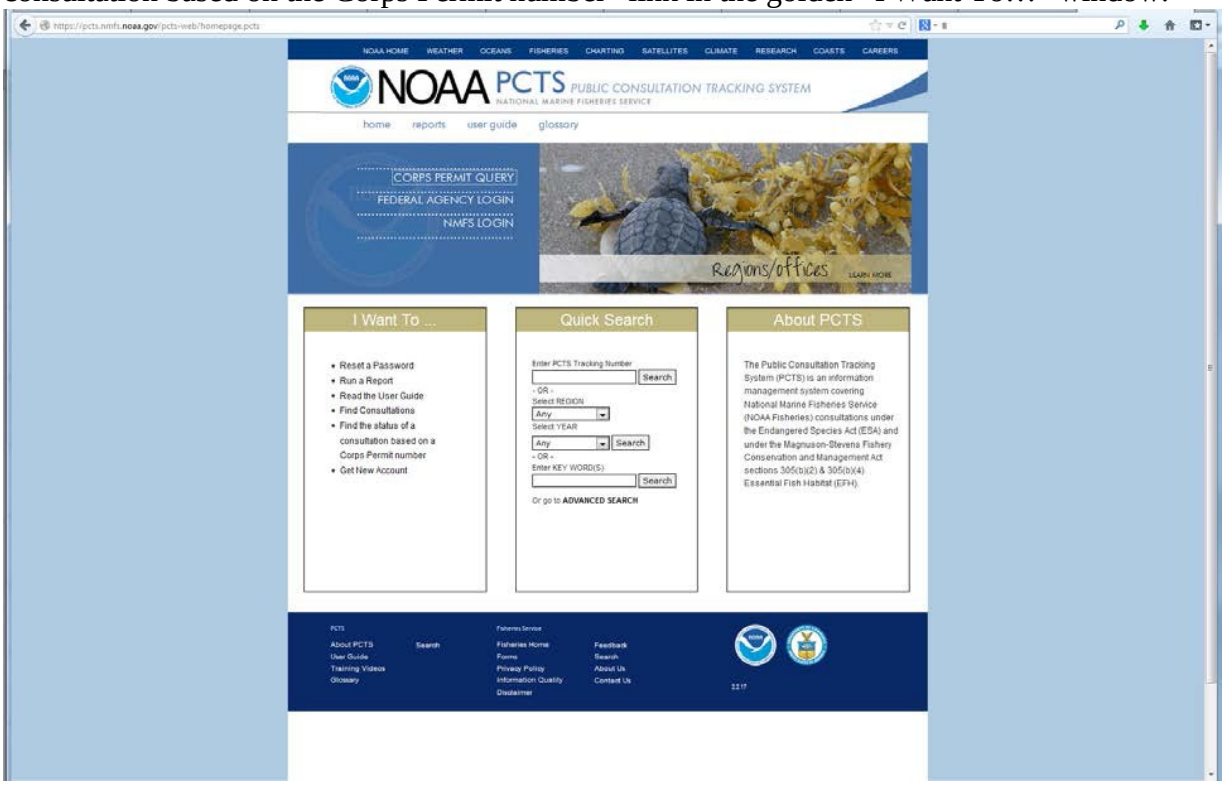
g. Any special construction conditions, required of your specific project, outside these general conditions, if applicable, will be addressed in the primary consultation.

Revised: March 23, 2006

PCTS Access and Additional Considerations for ESA Section 7 Consultations
(Revised 03-10-2015)

Public Consultation Tracking System (PCTS) Guidance: PCTS is a Web-based query system at **https://pcts.nmfs.noaa.gov/** that allows all federal agencies (e.g., U.S. Army Corps of Engineers - USACE), project managers, permit applicants, consultants, and the general public to find the current status of NMFS's Endangered Species Act (ESA) and Essential Fish Habitat (EFH) consultations which are being conducted (or have been completed) pursuant to ESA Section 7 and the Magnuson-Stevens Fishery Conservation and Management Act's (MSA) Sections 305(b)2 and 305(b)(4). Basic information including access to documents is available to all.

The PCTS Home Page is shown below. For USACE-permitted projects, the easiest and quickest way to look up a project's status, or review completed ESA/EFH consultations, is to click on either the "Corps Permit Query" link (top left); or, below it, click the "Find the status of a consultation based on the Corps Permit number" link in the golden "I Want To…" window.



Then, from the "Corps District Office" list pick the appropriate USACE district. In the "Corps Permit #" box, type in the 9-digit USACE permit number identifier, with no hyphens or letters. Simply enter the year and the permit number, joined together, using preceding zeros if necessary after the year to obtain the necessary 9-digit (no more, no less) number. For example, the USACE Jacksonville District's issued permit number SAJ-2013-0235 (LP-CMW) must be typed in as 201300235 for PCTS to run a proper search and provide complete and accurate results. For querying permit applications submitted for ESA/EFH consultation by other USACE districts, the procedure is the same. For example, an inquiry on Mobile District's permit MVN201301412 is entered as 201301412 after selecting the Mobile District from the "Corps District Office" list. PCTS questions should be directed to Kelly Shotts at Kelly.Shotts@noaa.gov or (727) 551-5603.

EFH Recommendations: In addition to its protected species/critical habitat consultation requirements with NMFS' Protected Resources Division pursuant to Section 7 of the ESA, prior to proceeding with the proposed action the action agency must also consult with NMFS' Habitat Conservation Division (HCD) pursuant to the MSA requirements for EFH consultation (16 U.S.C. 1855 (b)(2) and 50 CFR 600.905-.930, subpart K). The action agency should also ensure that the applicant understands the ESA and EFH processes; that ESA and EFH consultations are separate, distinct, and guided by different statutes, goals, and time lines for responding to the action agency; and that the action agency will (and the applicant may) receive separate consultation correspondence on NMFS letterhead from HCD regarding their concerns and/or finalizing EFH consultation.

Marine Mammal Protection Act (MMPA) Recommendations: The ESA Section 7 process does not authorize incidental takes of listed or non-listed marine mammals. If such takes may occur an incidental take authorization under MMPA Section 101 (a)(5) is necessary. Please contact NMFS' Permits, Conservation, and Education Division at (301) 713-2322 for more information regarding MMPA permitting procedures.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
http://sero.nmfs.noaa.gov

Nov, 21, 2018

F/SER31:DMB
SER-2018-19649

Daniel Czelusniak
Environmental Specialist
Federal Aviation Administration
800 Independence Avenue Southwest
Suite 325
Washington, DC 20591

Dear Mr. Czelusniak:

This letter responds to your request for re-initiation of consultation with us, the National Marine Fisheries Service (NMFS), pursuant to Section 7 of the Endangered Species Act (ESA) for the following action.

Applicant(s)	**SER Number**	**Project Type(s)**
Federal Aviation Administration (FAA), National Aeronautics and space Administration (NASA), and the U.S. Air Force (USAF)	SER-2018-19649	Waterborne landings of spacecraft

Consultation History
We completed consultation on the proposed action on August 8, 2016 (Public Consultation Tracking System [PCTS] identifier number SER-2016-17894). In that consultation, we determined the proposed action was not likely to adversely affect (NLAA) green sea turtle (North Atlantic and South Atlantic distinct population segments [DPSs]), Kemp's ridley sea turtle, leatherback sea turtle, loggerhead sea turtle (Northwest Atlantic DPS), loggerhead sea turtle designated critical habitat (Units LOGG-N-1 through LOGG-N-19, LOGG-S-1, and LOGG-S-2), hawksbill sea turtle, smalltooth sawfish (U.S. DPS), Gulf sturgeon, shortnose sturgeon, Atlantic sturgeon (Carolina and South Atlantic DPSs), North Atlantic right whale, North Atlantic right whale designated critical habitat (Unit 2), blue whale, fin whale, humpback whale, sei whale, and sperm whale.

On October 19, 2018, we received your letter requesting re-initiation of consultation due to our recent listing of the giant manta ray and the oceanic whitetip shark as threatened under the ESA (83 FR 2916 and 83 FR 4153, respectively). We re-initiated consultation on October 19, 2018.

Project Location

Address	Latitude/Longitude*	Water body
Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS) , Brevard County, Florida	28.608402ºN, 80.604201ºW (North American Datum 1983) Coordinates provided are for launch pad 39A. Other launch pads at the KSC and CCAFS may be used.	Atlantic Ocean
Texas SpaceX Launch Site, 2 miles east of Boca Chica Village, Cameron County, Texas	25.99684°N, 97.15523°W (World Geodetic System 1984)	Gulf of Mexico

All launch areas are located in upland areas and landing areas are located in open-water within the Atlantic Ocean or Gulf of Mexico, as shown in Figures 1 and 2 below. The open-water areas for planned landings start a minimum of 5 nautical miles offshore and exclude North Atlantic right whale critical habitat in the Atlantic Ocean.

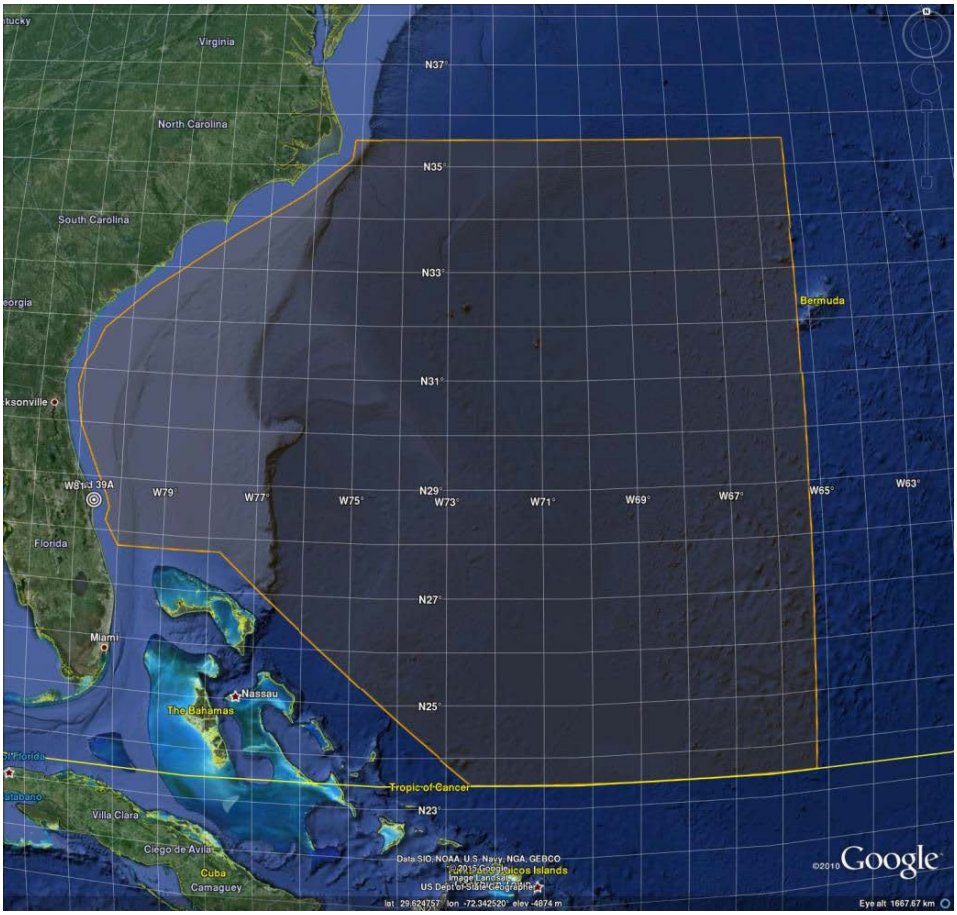


Figure 1. Representative image of action area in the Atlantic Ocean (Image provided by NASA)

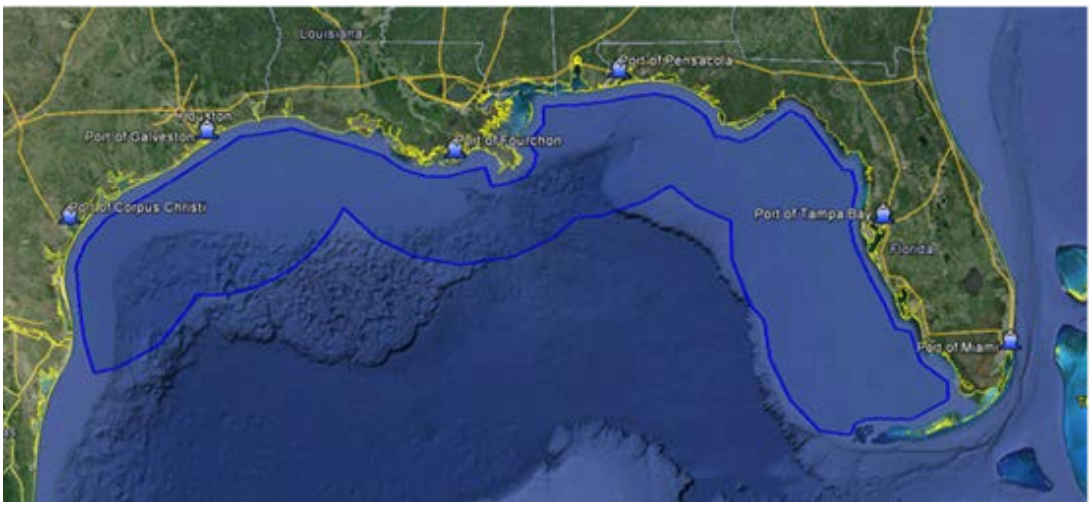


Figure 2. Representative image of action area in the Gulf of Mexico (Image provided by NASA)

Existing Site Conditions
Please refer to PCTS identifier number SER-2016-17894 for existing site conditions. The applicants have not identified any changes to the existing site conditions.

Project Description
Please refer to PCTS identifier number SER-2016-17894 for the existing project description. The applicants are not proposing any changes to the existing project description.

Construction Conditions
Please refer to PCTS identifier number SER-2016-17894 for construction conditions, including Education and Observation, Reporting, Vessel Traffic and Construction Equipment, and Hazardous Materials Emergency Response. The applicants are not proposing any changes to the existing construction conditions.

Effects Determination(s) for Species the Action Agency or NMFS Believes May Be Affected by the Proposed Action

Species	ESA Listing Status	Action Agency Effect Determination	NMFS Effect Determination
Fish			
Scalloped hammerhead shark (Central Atlantic [CA] and Southwest Atlantic [SWA] DPS)	T	--	NLAA
Giant manta ray	T	NLAA	NLAA
Oceanic whitetip shark	T	NLAA	NLAA
Marine Mammals			
Bryde's whale	E (Proposed)	--	NLAA
E = endangered; T = threatened; NLAA = may affect, not likely to adversely affect			

Please refer to PCTS identifier number SER-2016-17894 for the previous effect determinations for species occurring within the action areas. There are no changes to these determinations.

Critical Habitat

The action area is located in North Atlantic right whale critical habitat (Unit 2) and loggerhead sea turtle critical habitat (Units Logg-N-1 through Logg-N-19, Logg-S-1, and Logg-S-2). Please refer to the PCTS identifier number SER-2016-17894 for the previous effect determinations for these critical habitat units.

Because the action area in the Gulf of Mexico starts a minimum of 5 nautical miles offshore, the project is also located within the boundary of Gulf sturgeon critical habitat (Unit 14 – Suwannee Sound). The following primary constituent elements (PCEs) are present in Unit 14:

(1) Abundant prey items within estuarine and marine habitats and substrates for juvenile, subadult, and adult life stages;
(2) Water quality, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages;
(3) Sediment quality, including texture and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages; and
(4) Safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats (e.g., a river unobstructed by any permanent structure, or a dammed river that still allows for passage).

We believe only the water quality PCE of Gulf sturgeon critical habitat (Unit 14 – Suwannee Sound) may be affected by the proposed action.

Analysis of Potential Routes of Effects to Species

Scalloped hammerhead shark, giant manta ray, oceanic whitetip shark, and Bryde's whale may be affected by open-water landings if they were to be struck by falling materials, spacecraft, or controlled burn water landings. We believe that it is highly unlikely that these species will be struck and that the effects are discountable given the relatively small size of capsules (less than 200 ft^2) compared to the open ocean. These launches have been occurring for decades with no known interactions with these species. Further, launches will occur intermittently (approximately every few months) and the goal is to ultimately reduce and eliminate the need for open-water landings.

Scalloped hammerhead shark, giant manta ray, oceanic whitetip shark, and Bryde's whale may become entangled in the parachutes that will transport the capsule to the water surface. However, we believe the risk of entanglement is discountable. Due to their high mobility, these species will likely avoid the area immediately following a landing. Additionally, all materials will be retrieved quickly (approximately 1 hour). As stated previously, the ultimate goal is to reduce the need for open-water landings, thus reducing the need for parachutes.

Scalloped hammerhead shark, giant manta ray, oceanic whitetip shark, and Bryde's whale may be affected by any hazardous materials spilled into the Atlantic Ocean or Gulf of Mexico during the proposed action. For planned marine landings, all fuel valves will shut automatically prior to

landing to retain any residual fuels. We believe any effect to these species from a hazardous materials spill is discountable. While a small fuel spill is possible, hazardous material spills are highly unlikely due to the NASA's 98-99% success rate. Further, failed missions do not necessarily occur over marine waters, and most, if not all, fuel would be consumed (e.g., during an explosion) or contained (according to the applicant's Hazardous Material Emergency Response Plan) during a failed mission.

Analysis of Potential Routes of Effect to Critical Habitat

Water quality, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages (PCE 2) of Gulf sturgeon critical habitat (Unit 14 – Suwannee Sound) may be affected by any hazardous materials spilled into Gulf of Mexico during the proposed action. We believe the effect to PCE 2 from a hazardous materials spill is discountable. While a small fuel spill is possible, hazardous material spills are highly unlikely due to the NASA's 98-99% success rate. Further, failed missions do not necessarily occur over marine waters, and most, if not all, fuel would be consumed (e.g., during an explosion) or contained (according to the applicant's Hazardous Material Emergency Response Plan) during a failed mission.

Conclusion

Because all potential project effects to listed species and critical habitat were found to be discountable, insignificant, or beneficial, we conclude that the proposed action is not likely to adversely affect listed species and critical habitat under NMFS's purview. This concludes your consultation responsibilities under the ESA for species under NMFS's purview. Consultation must be reinitiated if a take occurs or new information reveals effects of the action not previously considered, or if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat in a manner or to an extent not previously considered, or if a new species is listed or critical habitat designated that may be affected by the identified action. NMFS's findings on the project's potential effects are based on the project description in this response. Any changes to the proposed action may negate the findings of this consultation and may require reinitiation of consultation with NMFS.

We look forward to further cooperation with you on other projects to ensure the conservation of our threatened and endangered marine species and designated critical habitat. If you have any questions on this consultation, please contact Dana Bethea, Consultation Biologist, at (727) 209-5974, or by email at Dana.Bethea@noaa.gov.

Sincerely,

David Bernhart
Assistant Regional Administrator
for Protected Resources

File: 1514-22.v

APPENDIX F

Cultural Resource Documents

TECHNICAL MEMO

Phase I Cultural Resources Assessment Survey Near Launch Complex 20, Cape Canaveral Air Force Station, Brevard County, Florida

Prepared for:

45th Space Wing

Cape Canaveral Air Force Station

1224 Jupiter Street

Patrick Air Force Base, FL 32925

Prepared by:

University of South Florida Libraries

Digital Heritage and Humanities Center

4202 East Fowler Avenue LIB 122

Tampa, FL 33620

www.lib.usf.edu/dhhc/

Jaime A. Rogers, M.A.
Project Archaeologist

Lori D. Collins, Ph.D.
Co-Principal Investigator

Travis F. Doering, Ph.D.
Co-Principal Investigator

June 2019

INTRODUCTION

The University of South Florida's Digital Heritage and Humanities Center (DHHC) is conducting ongoing cultural resource assessment surveys (CRAS) of multiple land management units (LMUs) along ICBM road on Cape Canaveral Air Force Station (CCAFS). These projects were performed to comply with Section 110(a)(2)(D) of the National Historic Preservation Act (NHPA). The current technical memo describes our methods and results within LMUs 15 and 18, north and south of Launch Complex 20 (LC-20), respectively (**Figure 1**). LMUs 15 and 18 are part of different ongoing DHHC projects. LMU 15 is under the LMU 13-17 project, which fieldwork is completed for and report writing is underway. LMU 18 is under the ICBM project, which fieldwork is currently underway. Shovel testing is complete in both LMUs.

METHODS

Because this was a Section 110 project, our survey method focused on testing a site probability model created in ArcGIS Pro, rather than overlying an arbitrary shovel test grid on an Area of Potential Effect (APE) as is more common with Section 106 projects. The suitability model generated zones of high, medium, and low site probability, which were tested at 25m, 50m, and 100m intervals, respectively. Several Basic Information Guides (BIGs) from the 50s, 60s, 70s, 90s, and 00s were georeferenced and compared with field findings. Additionally, 2019 FMSF GIS data and previous surveys were reviewed.

RESULTS

A total of 119 shovel tests were excavated within LMU 15. All were negative for cultural material (**Figure 2**). Of the 119 shovel tests, 47 were noted as being disturbed or possibly disturbed. Soil drainage was also recorded, 76 were noted as being well-drained, 30 were medium, and 13 were poorly drained. The poorly drained shovel tests were concentrated in the northeast portion of the LMU.

Generally speaking, the majority of profiles in the south and central areas showed evidence of disturbance. Fill was often observed on the surface in these areas. The shovel tests along the dune ridges, while elevated, showed no evidence of cultural material. Those to the west were not disturbed but were also sterile and within very dense vegetation. The central portion of this LMU had very dense vegetation, but given the low elevation and disturbed surroundings, we do not think there is much probability of encountering sites within the untested area. Clay inclusions or sandy clay strata were noted in a few shovel tests, but there is no spatial pattern between them. Minimal shell inclusions were relatively common throughout most of the LMU. The majority of the tests noted as being disturbed also had small rock inclusions as well. The location of the disturbed tests often aligns with clearings in the historic aerials, although some tests are outside of the apparent disturbance zones.

A total of four Air Force facilities were encountered within LMU 15 (**Figure 3**). Two are identified as a Weather Tower 006 (F. 22101) and associated equipment building (F. 22100) (**Figure 4**). These were constructed in 1990 in the same location as historic structures that served the same function (F. 15523A and F. 15523B). The remnants of the historic facilities were not encountered. Given the year the new weather tower was constructed, the two facilities will not be recorded.

The other two structures are currently unidentified. The first is a small fenced-in area with metal and wood remains (**Figure 5**). When BIGs are georeferenced, the remnants are within 20m of F. 15530, but this facility number designates a contaminated liquids pond. The next closest facility is 90m away and is

a Theodolite Building (15521A); however, the structural information provided on the BIGs do not align with the structural remains encountered. It is likely that this facility was short lived during the 80s, given our gap of BIGs during this time. However, there is also a possibility that this structure is pre-Air Force. Regardless, this structure remains unidentified. However, given its small size and deteriorating condition, the DHHC would more than likely recommend the structure ineligible for listing on NRHP.

Lastly, another unidentified structure is present 75m east of Weather Tower 006 (**Figures 6 and 7**). This facility remains unlabeled on BIGs, except for the general area being described as Thrust Block and Valve Pit on the 1966 BIG. Additional maps and documents are currently being reviewed to try and confirm the identity of this structure.

A total of 96 shovel tests were excavated within LMU 18. All were negative for cultural material (**see Figure 2**). Only eight were described as being disturbed. The majority of the disturbed tests are in the southern portion of the LMU boundary. The vast majority of soil was described as being well-drained, some medium-drained, and none were described as being poorly drained. Stratigraphy described in LMU 18 is very similar to those outlined in LMU 15 above.

A total of three Air Force structures were encountered in LMU 18 (**see Figure 3**). In the southern portion of LMU 18, the DHHC encountered a small vented structure with a tunnel attached (**Figure 8**). After a review of an Engineering report done by AMRO (Eley et al. 1962), we have preliminarily identified the structure as an escape tunnel (**Figure 9**). Eley et al. (1962:51) depict a typical launch complex layout. Although their example uses LC-15 and LC-16, the layout for LC-19 should be the same or very similar. **Figure 9** indicates an Air Vent and Escape Tunnel leading northwest from the Blockhouse in the same location as the structure observed by the DHHC. Therefore, the DHHC likely encountered the terminus of the escape tunnel for LC-19 and will be recorded as a structure within the Resource Group associated with LC-19 (8BR216).

The second structure is currently unidentified. It consists of a metal hatched door overlying a few pumps that are currently inundated (**Figure 10**). When georeferenced with BIGs, the closest facilities are storage buildings and an electric substation. We do not currently have a preliminary identification for this structure but considering its size and presumed limited function, we would likely not recommend this eligible for NRHP.

The third structure encountered in LMU 18 is the same type of structure encountered in LMU 15 and has the same location in relation to the respective launch complex (LC-19) (**Figure 11**). Therefore, the structure has been temporarily called a Thrust Block and Valve Pit until a positive identification can be confirmed.

CONCLUSIONS

Fieldwork around LC-20 has been completed, but the identification of Air Force structures within LMUs 15 and 18 is ongoing. In total, five historic structures were encountered. Two are preliminarily identified as Thrust Block and Valve Pit structures associated with LC-19 and LC-20. One is preliminarily identified as an Air Vent and Escape Tunnel associated with LC-19. The remaining two are currently unidentified. The DHHC will continue to review historic maps and documents to try and determine the temporality and function of all of the structures mentioned in this memo. No evidence of prehistoric habitation was encountered in either LMU.

APPENDIX A: FIGURES

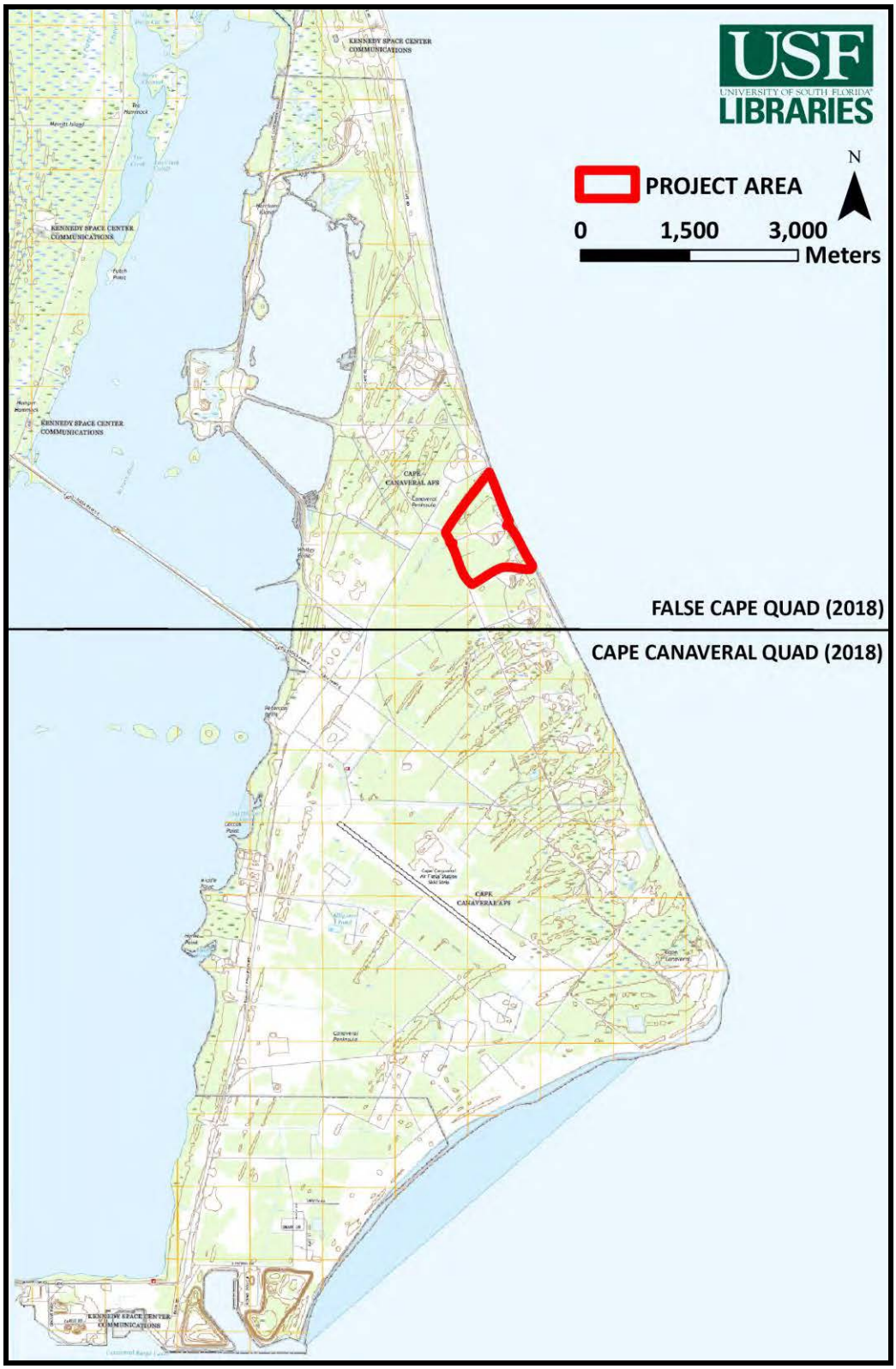


Figure 1. Project area (red) discussed in this memo (LMUs 15 and 18 on CCAFS).

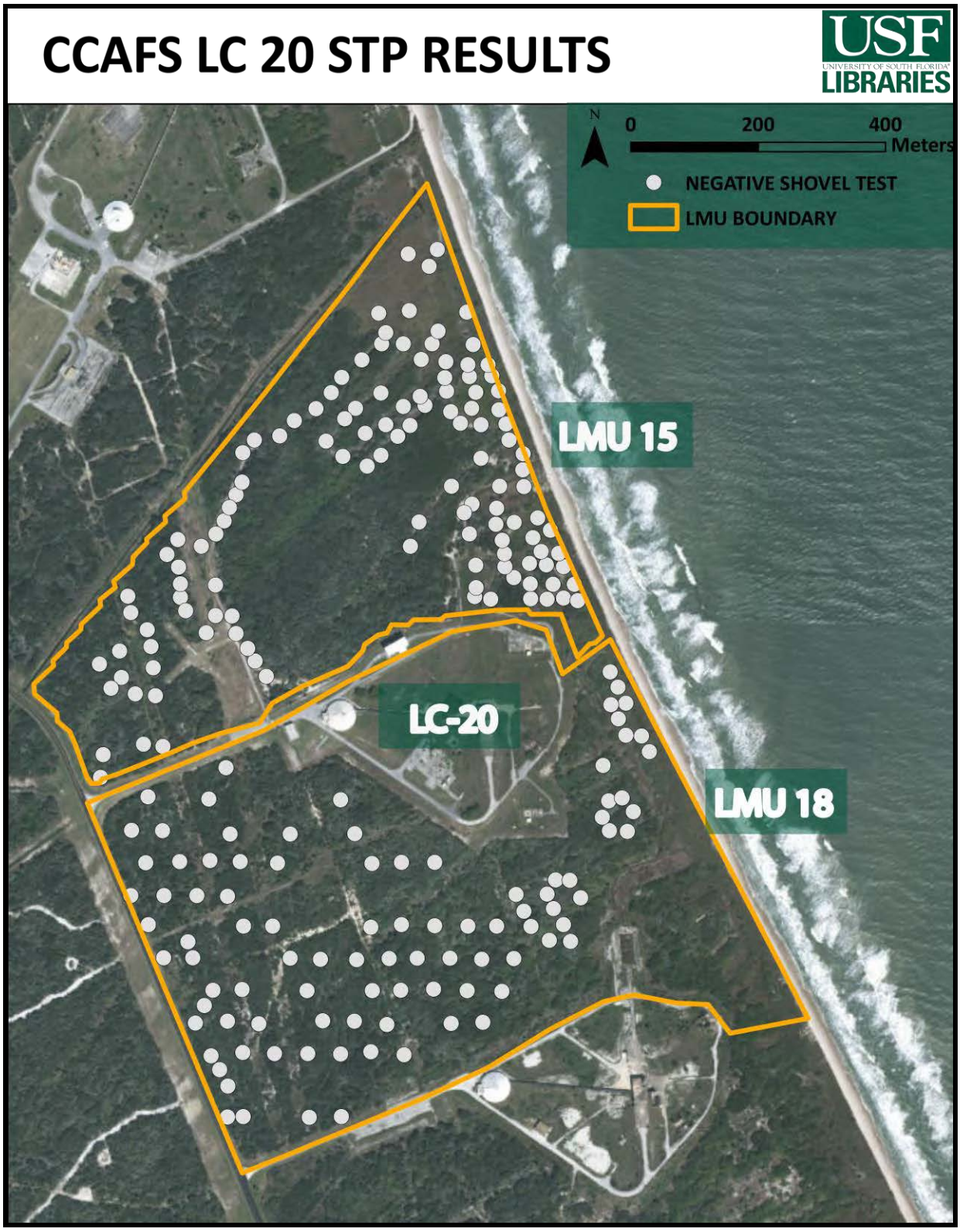


Figure 2. STP results for LMUs 15 and 18.

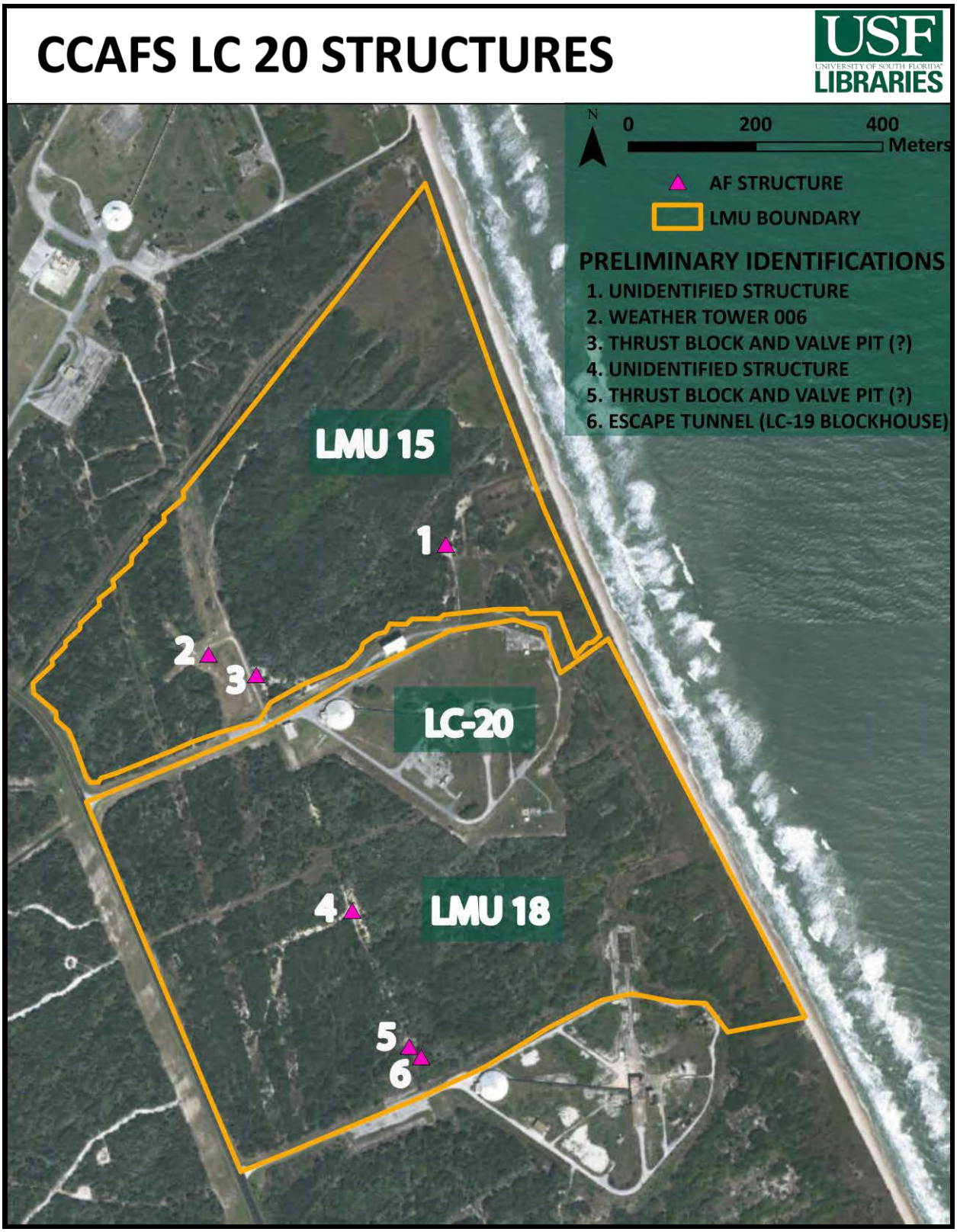


Figure 3. Structures located within LMUs 15 and 18.

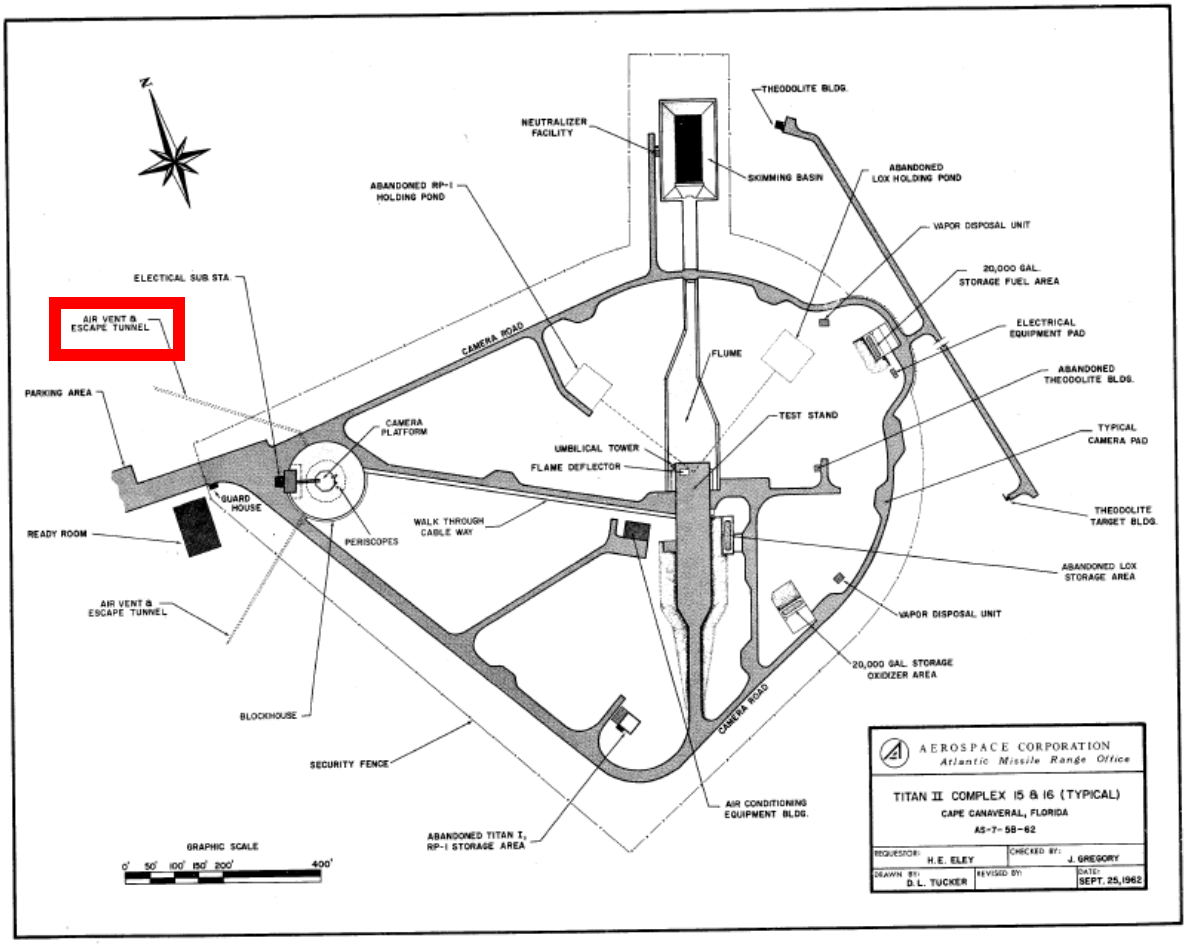
Figure 4. Weather Tower 006 (F. 22101) in the southeast portion of LMU 15 - view facing W.

Figure 5. Unidentified structure (wood and metal remains) in LMU 15 - view facing E.

Figure 6. Backside of structure preliminarily identified as a Thrust Block and Valve Pit – view facing W.

Figure 7. View of water pump on structure preliminarily identified as a Thrust Block and Valve Pit - view facing S.

Figure 8. Vented structure attached to a tunnel located in LMU 18 - view facing S.



II

Figure 9. AMRO Engineering Staff (1962:51) LC 15/16 Plan View. Escape tunnel highlighted in red (Figure II.26).

Figure 10. Unidentified structure in LMU 18.

Figure 11. Similar structure to the one found in LMU 15. Preliminarily identified as a Thrust Block and Valve Pit - view facing N.

WORK CITED

Eley, H. E., T. J. Bryan, Jack L. Gregory, R. L. Thibault, and J. W. Tolbert
1962 The AMRO Handbook Volume VI: Atlantic Missile Range Launch Facilities. Prepared by the AMRO Engineering Staff. Aerospace Corporation. Report No. ATM-63. On File with Pan American World Airways Inc. Master Planning.

FLORIDA DEPARTMENT of STATE

RON DESANTIS
Governor

LAUREL M. LEE
Secretary of State

Mr. Michael A. Blaylock
Chief, Environmental Conservation
45 CES/CEIE
1224 Jupiter Street, MS-9125
Patrick AFB, FL 32925-3343

September 12, 2019

RE: DHR Project File No.: 2019-5045
Proposed Reuse of Launch Complex 20 (LC-20)
Cape Canaveral Air Force Station, Brevard County, Florida

Mr. Blaylock:

Our office received and reviewed the above referenced project in accordance with Section 106 and Section 110 of the *National Historic Preservation Act of 1966*, for possible impact to historic properties listed, or eligible for listing, in the *National Register of Historic Places*.

A review of our files indicates that this office has previously determined that Facility 18800 - LC-20 Blockhouse (8BR3155 appears to meet the criteria for listing on the *National Register*. However, based on the information provided, this office concurs with your determination that the proposed undertaking will have no adverse effect on the historic character of the blockhouse or other historic resources.

If you have any questions, please contact Scott Edwards, Historic Preservationist, by electronic mail *scott.edwards@dos.myflorida.com*, or at 850.245.6333 or 800.847.7278.

Sincerely,

Jason Aldridge
For

Timothy A. Parsons, Ph.D.
Director, Division of Historical Resources
and State Historic Preservation Officer

FLORIDA DEPARTMENT of STATE

RON DESANTIS
Governor

LAUREL M. LEE
Secretary of State

Chris Stahl
Florida State Clearinghouse
Florida Department of Environmental Protection
2600 Blair Stone Road, M.S. 47
Tallahassee, FL 32399-2400

June 9, 2020

RE: DHR Project File No.: 2020-3034
Project: SAI# FL202005128941C
Department of Defense – Department of the Air Force
Environmental Assessment for the Reconstitution and Enhancement of Space Launch Complex 20 Multi-User Launch Operations
Cape Canaveral Air Force Station, Brevard County

Mr. Stahl:

The Florida State Historic Preservation Officer reviewed the referenced project for possible effects on historic properties listed, or eligible for listing, on the National Register of Historic Places. The review was conducted in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations in 36 CFR Part 800: Protection of Historic Properties.

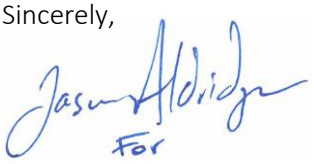
We have reviewed Sections 3.4, 4.4 and 5.3.4 of the referenced document which deal with Cultural Resources. The 45th Space Wing Cultural Resources Manager evaluated the areas that would be affected by the Proposed Action, and no historical or cultural resource issues were found within the Proposed Action boundaries or surrounding areas with the exception of Facility 18800 - LC-20 Blockhouse (8BR3155).

The Blockhouse was previously determined by this office to appear to meet the criteria for listing in the *National Register*. The Proposed Action proposes to use the facility as it was originally intended and to maintain the exterior similar to its original construction.

Therefore, based on the information provided, it is the opinion of this office that the document has adequately addressed cultural resources and it is our opinion that proposed undertakings will have no adverse effect on the historic character of the blockhouse or other historic resources.

If you have any questions, please contact Scott Edwards, Historic Preservationist, by electronic mail scott.edwards@dos.myflorida.com, or at 850.245.6333 or 800.847.7278.

Sincerely,



Timothy A. Parsons, Ph.D.
Director, Division of Historical Resources
and State Historic Preservation Officer

APPENDIX G

Transportation Concurrence Correspondence

Re: Re-Issue of permit #072919-1 with correct route

Gaddis, Gregory (KSC-SII10) <gregory.gaddis-1@nasa.gov>
Wed 7/31/2019 6:56 PM

To: Priyanka Valletta <pprakash@brph.com>; Huff, Patrick D. (KSC-BOSS-4240)[PAE - SGT Partners LCC] <patrick.d.huff@nasa.gov>

Good Evening Pri...!

The permit isn't a requirement for the EA... and it was me that questioned the use of that specific bridge.

Given the answer Patrick worked up for us, I'm confident there will be no issues with the route...

The specific permit can be worked when the customer is actually within a few weeks of the actual transport...

Hope that helps...!

THANKS!

Greg "Tremendously Awesome" Gaddis
*** *It's an attitude... not a self-assessment* ***
KSC Master Integrator
Customer Service & Integration Branch
321-861-9556 (Office)

Sent from my iPhone

On: 31 July 2019 18:31, "Priyanka Valletta" <pprakash@brph.com> wrote:

> Hi Greg, hi Patrick,
>
> I promise to quit bugging you guys on this one soon. ☺
> Can we get a revised permit with the updated vehicle dimensions (12' wide, 14' high)?
>
> So no issues with using the Roy Bridges bridge from a weight limit perspective?
>
> Just wanted to make sure so we're covered for the EA.
>
> Thanks!
> Pri
>
> **Priyanka Valletta** PE
> **Civil Engineer**
>
> **EMAIL** pvalletta@brph.com
> **DIRECT** 321-751-3095
> **CELL** 321-243-2584
> **FAX** 321-259-4703
>
> **BRPH** | 5700 North Harbor City Boulevard, Suite 400 | Melbourne, Florida 32940 | **BRPH.com**
>
> *Engineering News-Record Top 500 Design Firms - 2018*
>
> ---
>
> **From:** Priyanka Valle a <pprakash@brph.com>
> **Sent:** Tuesday, July 30, 2019 9:41 AM
> **To:** Gaddis, Gregory (KSC-SII10) <gregory.gaddis-1@nasa.gov>
> **Subject:** Re: Re-Issue of permit #072919-1 with correct route
>
> Most likely not until after Jan 2021. Initial launches are targeted for the start of 2021, but the manufacturing may not begin in Florida until later in the year 2021.
>
> **Priyanka Valletta** PE
> **Civil Engineer**
>
> **EMAIL** pvalletta@brph.com
> **DIRECT** 321-751-3095
> **CELL** 321-243-2584
> **FAX** 321-259-4703
>
> **BRPH** | 5700 North Harbor City Boulevard, Suite 400 | Melbourne, Florida 32940 | **BRPH.com**

From: Gaddis, Gregory (KSC-SII10) <gregory.gaddis-1@nasa.gov>
Sent: Tuesday, July 30, 2019 8:26 AM
To: Priyanka Valle a <pprakash@brph.com>
Subject: RE: Re-Issue of permit #072919-1 with correct route

You bet… even more of a requirement for the escort…!

When might the customer start moving hardware…???

THANKS!

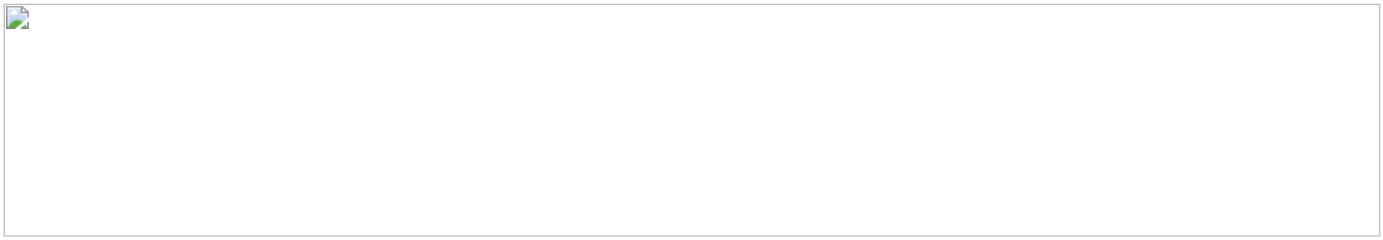
Greg "Tremendously Awesome" Gaddis
**** It's an attitude…not a self-assessment ****
KSC Master Integrator
Customer Service & Integration Branch (SI-I1)
321-861-9556 (Office)

From: Priyanka Valle a <pprakash@brph.com>
Sent: Tuesday, July 30, 2019 8:24 AM
To: Gaddis, Gregory (KSC-SII10) <gregory.gaddis-1@nasa.gov>
Subject: [EXTERNAL] Re: Re-Issue of permit #072919-1 with correct route

Hi Greg!

Thanks for following up on this one. Yes, I think when we get closer to operations, the customer would prefer to have an escort.

One note on the updated permit--can we modify the height and width to the 12' wide and 14' height?



Thanks!
Pri

Priyanka Valletta PE
Civil Engineer

EMAIL pvalletta@brph.com
DIRECT 321-751-3095
CELL 321-243-2584
FAX 321-259-4703

BRPH | 5700 North Harbor City Boulevard, Suite 400 | Melbourne, Florida 32940 | **BRPH.com**

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FW: Re-Issue of permit #072919-1 with correct route

Gaddis, Gregory (KSC-SII10) <gregory.gaddis-1@nasa.gov>

Tue 7/30/2019 7:55 AM

To: Priyanka Valletta <pprakash@brph.com>

1 attachments (57 KB)

072919-1.pdf;

Good Morning Pri…!

As we discussed earlier… When we get close to doing these operations, I believe you'll find that CCAFS Security will be escorting you across KSC to SLC-20… this is STRONGLY recommended…especially with flight hardware.

Let me know how I may facilitate your success in the future…!

THANKS!

Greg "Tremendously Awesome" Gaddis
*** *It's an attitude...not a self-assessment* ***
KSC Master Integrator
Customer Service & Integration Branch (SI-I1)
321-861-9556 (Office)

From: Huff, Patrick D. (KSC-BOSS-4240)[PAE - SGT Partners LCC] <patrick.d.huff@nasa.gov>
Sent: Tuesday, July 30, 2019 7:52 AM
To: Pri Valletta (KSC)[BRPH ARCHITECTS ENGINEERS INC] <pprakash@brph.com>; KSC-Boss-DUTYOFFICE <KSC-BOSS-DUTYOFFICE@mail.nasa.gov>
Cc: KSC-DL-BOSS-MISSION-COORDINATORS <KSC-DL-BOSS-MISSION-COORDINATORS@mail.nasa.gov>; Gaddis, Gregory (KSC-SII10) <gregory.gaddis-1@nasa.gov>; Mullen, Brian J. (KSC-BOSS-4240)[PAE - SGT Partners LCC] <brian.j.mullen@nasa.gov>
Subject: Re-Issue of permit #072919-1 with correct route

This is a Self-Escort permit. If KSC Escorts are desired, contact BOSS Duty Office.

PATRICK D. HUFF, P.E.
Team Lead Civil & Structural Design Engineering
Base Operations & Spaceport Services (BOSS)
Bldg. K6-1096 | Room 2303-R2
Kennedy Space Center, Florida 32899
o: 321-861-4664
e: patrick.d.huff@nasa.gov

PERMIT FOR OVERWEIGHT/OVERSIZE ROADWAY VEHICLE AT KSC

PERMIT MUST BE IN VEHICLE AT ALL TIMES

DATE OF ISSUE: **7/29/2019**	EXPIRATION DATE: **9/29/2019**	ROUTE: **Space Commerce Way/NASA Parkway/Gate 3/Banana River Bridge/CCAFS**
PERMIT #: **072919-1**	OPERATOR / POINT OF CONTACT: Priyanka Valletta	PHONE #: 321-243-2584
VEHICLE: **Truck Semi-Trailer hauling Flight Hardware**	HEIGHT: **13'-6"**	WIDTH: **8'-0"** / LENGTH: **80'-0"**

NO. OF AXLES: **4**

AXLE WEIGHTS: **Legal (80K GVWR)**

- ☒ ATTACHMENT A: ROUTE
- ☐ ATTACHMENT B: AXLES AND DIMENSIONS
- ☐ ATTACHMENT C: LOAD PLATES

☒ Prior permits Void- Route is limited to: same as above	☐ Transit under Kennedy Parkway overpass prohibited.
☐ Load distribution plates are required per Attachment C for Pad A/B Bypass Road culverts. All hardware is to be provided by Permittee.	☐ Movement against oncoming traffic requires traffic be blocked.
☐ Maximum Speed on bridges is 5 mph. ***Convoy commander will review speed requirements with permit vehicle operator. Lead escort vehicle will maintain maximum speed and remain in front of escorted vehicle at all times.***	☐ Requester must submit a request for route approval and or escort support from Support Operations Center (853-5211) and contact BOSS Duty Office @ 321-861-5050 on KSC. If using CCAFS, contact the Air Force watch commander (853-2159) prior to movement. Verify bridges & facilities are in-service prior to scheduled move.
☐ Vehicle centered on all bridge spans. ***No stopping, no accelerating. Convoy commander will use the lead escort vehicle as a point of reference for permit vehicle driver and maintain the escort vehicle in the center of the bridge spans.***	☐ KSC Security Escort, operations, route preparation, and flagging required per OMI-Q-3745. ☒ Permittee self-escort, operations, route preparation, and flagging required per OMI-Q-3745.
☐ Wind speed shall be 25 mph or less on bridge.	

The requestor is responsible for ensuring that all operations comply with the requirements in the current KNPR 6000.1. This authorization / permit prescribes equipment configuration for the movement of overweight / oversize equipment on KSC & CCAFS. For further information, contact BOSS Design Engineering at 861-4664. This authorization permits the movement of the equipment in the configuration as described above in accordance with the noted restrictions / requirements. If the configuration changes at any time this permit becomes invalid.

NOTE: This is a multiple vehicle configuration permit. The operator is to perform route survey to verify no obstructions prior to transit.

Approvals:

7/30/2019 X  Signed by: Patrick Huff (affiliate) **Name/Title:** Patrick Huff, P.E.	7/30/2019 X Brian Mullen Signed by: Brian Mullen (affiliate) **Name/Title:** Brian Mullen, Engineer 2

RE: Firefly Transportation Route for EA

WALLACE, BRIAN K GS-12 USAF AFSPC 45 CES/CENMP <brian.wallace.1@us.af.mil>

Wed 7/24/2019 11:04 AM

To: Priyanka Valletta <pprakash@brph.com>
Cc: DEAL, GREGORY A GS-12 USAF AFSPC 45 CES/CEZL <gregory.deal.1@us.af.mil>; LONG, EVA M CIV USAF AFSPC 45 CES/CEIE <eva.long@us.af.mil>; Pete Eggert <PEggert@spaceflorida.gov>; Jaculin Watkins <jwatkins@brph.com>; Steve Berry <saberry@lg2es.com>; Benjamin (BJ) Bukata <BBukata@jonesedmunds.com>

Pri,

Your message below provides all the information required for a route study. The information documents that there are no issues with the transportation route relative to the planned transport and cargo. The vehicle weight and type is within the design parameters of the roadway, and in general the vehicle and cargo is typical to those of FDOT roadways.
Given this, I concur that providing the information below in the transportation route section of the EA will serve as the route study in lieu of providing a standalone route study document. One caveat, as you noted, the Roy Bridges bridge is still under review. If NASA finds the bridge can accommodate the planned transport and cargo, then the route will be acceptable to all parties. If not, an alternate route to CX20 will have to be submitted and approved.
However, for the proposed route, it appears all objectives of the route study for CCAFS have been met, and with that, the meeting schedule for 1430 today can be canceled.

Thank you so much for providing the information below.

Very Respectfully,

Brian K. Wallace, PE
45 CES/CENMP
PHN: 321-853-0922
DSN: 467-0922

From: Priyanka Valletta <pprakash@brph.com>
Sent: Tuesday, July 23, 2019 6:04 PM
To: WALLACE, BRIAN K GS-12 USAF AFSPC 45 CES/CENMP <brian.wallace.1@us.af.mil>
Cc: DEAL, GREGORY A GS-12 USAF AFSPC 45 CES/CEZL <gregory.deal.1@us.af.mil>; LONG, EVA M CIV USAF AFSPC 45 CES/CEIE <eva.long@us.af.mil>; Pete Eggert <PEggert@spaceflorida.gov>; Jaculin Watkins <jwatkins@brph.com>; Steve Berry <saberry@lg2es.com>; Benjamin (BJ) Bukata <BBukata@jonesedmunds.com>
Subject: [Non-DoD Source] Re: Firefly Transportation Route for EA

Hi Brian!

Thanks for your time today on the phone. Below are my notes--feel free to add/adjust anything I may have missed. I think we have a pretty clear idea of what needs to be done moving forward to address the transportation route requirements for the EA. Let me know if you still would like to have a call tomorrow to discuss.

We are following up with similar conversations with the NASA POC's, particularly regarding use of the Roy Bridges bridge.

Thanks,

Pri

- NASA will need to determine the suitability for the route & Roy Bridges bridge for the proposed vehicle and loads on the KSC side.
- On the CCAFS side of the route:
    - **Vehicle loads/weight:**
        - The CCAFS roads were designed to FDOT specifications to accommodate an HS-20 traffic loading.
        - Firefly will be using a standard tractor trailer and will stay within FDOT maximum weights for an HS-20 vehicle loading (8 kips on front axle, 32 kips for rear axles), for a maximum allowable weight of 80,000 lbs.
        - ***As the weights will be within FDOT standard weight limits, no additional improvements to the route are anticipated to accommodate the vehicle weight.***
    - **Vehicle dimensions and maneuvering:**
        - Firefly will be using a standard tractor trailer with an extension for a maximum length of 80'. This is comparable to (and slightly smaller than) the overall length of an AASHTO WB-96 or WB-114 vehicle. These vehicles require a minimum of 21', and 17' inside turning radius measured from the inside wheel, and 50' and 60' turning radius measured from the outside wheel respectively.
        - The four main intersections on CCAFS where these turning maneuvers will occur are:
            - **NASA Parkway/Samuel C. Phillips Parkway.** The inside radius of the pavement appears to be at least 40'. This intersection will also be receiving additional pavement as part of the EDTPF project. The roadway width of each road is at least 24', so this should accommodate the required outside wheel turning radii as well.
            - **Samuel C Phillips Parkway and Heavy Launch Road.** This maneuver does not require a sharp turn (approx. 20 degree change in alignment) and the radius of the turn in the existing pavement is very large (100' feet).
            - **Heavy Launch Road and ICBM Road.** The inside radius of the pavement appears to be at least 60'.
            - **ICBM Road and SLC-20.** The inside radius of the pavement appears to be at least 90'.
        - These inside radii are greater than the minimum required inside radii for the comparable AASHTO vehicles.
        - ***Based on the observations above, no additional improvements to the route are anticipated to accommodate the vehicle dimensions and turning maneuvers.***
    - Hazardous material:
        - Firefly will not be transporting ordnance along the proposed route.
    - General:
        - The information above will be summarized in the transportation route section of the EA in lieu of providing a standalone route study document.
        - We will include a note in the EA that oversized loads utilizing this route will be coordinated with Cape Support prior to artifact delivery.

- It is recommended that the customer inspect the route prior to delivery. We discussed that the customer may place steel plates over any culverts along the route at their discretion; however, given that the weights will not exceed FDOT weight restrictions, it is not anticipated that these will be needed.

Priyanka Valletta PE

Civil Engineer

EMAIL pvalletta@brph.com
DIRECT 321-751-3095
CELL 321-243-2584
FAX 321-259-4703

BRPH | 5700 North Harbor City Boulevard, Suite 400 | Melbourne, Florida 32940 | **BRPH.com**

Engineering News-Record Top 500 Design Firms - 2018

From: Priyanka Valletta
Sent: Monday, July 22, 2019 1:00 PM
To: WALLACE, BRIAN K GS-12 USAF AFSPC 45 CES/CENMP <brian.wallace.1@us.af.mil>
Cc: DEAL, GREGORY A GS-12 USAF AFSPC 45 CES/CEZL <gregory.deal.1@us.af.mil>; LONG, EVA M CIV USAF AFSPC 45 CES/CEIE <eva.long@us.af.mil>; Pete Eggert <PEggert@spaceflorida.gov>; Jaculin Watkins <jwatkins@brph.com>
Subject: Firefly Transportation Route for EA

Hi Brian,

Eva suggested I reach out to you directly to discuss this possibly in lieu of the meeting on Wednesday. Attached is the language and description we are including in the SLC-20 EA for the travel route.

Upon further discussions with Firefly, they will be using a standard tractor trailer with an extension for a total length no longer than 80', and that the transported stages would meet FDOT weight limits (80,000 lbs max, HS-20 axle loadings). The stages will be transported from Exploration Park to the SLC-20 facility for assembly, with about 2 trips for each Alpha vehicle and 2-3 trips for each Beta vehicle. Given that these are standard loadings, would a route evaluation study still be necessary? If so, does this need to be done prior to release of the EA, or can this be done prior to using the route for delivery?

We're trying to determine how to best address this subject in the EA. Could you please give me a call on my cell below when you get a chance?

Thank you!
Pri

Priyanka Valletta PE

Civil Engineer

EMAIL pvalletta@brph.com

DIRECT 321-751-3095
CELL 321-243-2584
FAX 321-259-4703

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Engineering News-Record Top 500 Design Firms - 2018

APPENDIX H

Florida State Clearinghouse Correspondence

LONG, EVA M CIV USSF SPOC 45 CES/CEIE

From: Stahl, Chris <Chris.Stahl@dep.state.fl.us>
Sent: Wednesday, July 1, 2020 4:14 PM
To: LONG, EVA M CIV USSF SPOC 45 CES/CEIE
Cc: State_Clearinghouse
Subject: [Non-DoD Source] State Clearance Letter for FL202005128941C- Environmental Assessment For The Reconstitution And Enhancement Of Space Launch Complex 20 Multi-User Launch Operations At Cape Canaveral Air Force Station, Brevard County, Florida
Attachments: 2020 3034 - Clearinghouse - SCH 106 USAF CCAFS.pdf

July 1, 2020

Eva Long
U.S. Air Force
45 CES/CEI
Samuel C Phillips Pkwy,
Cape Canaveral Air Force Station, Florida 32925

RE: Department of Defense, Department of the Air Force, U.S. Air Force, Environmental Assessment For The Reconstitution And Enhancement Of Space Launch Complex 20 Multi-User Launch Operations At Cape Canaveral Air Force Station, Brevard County, Florida
SAI # FL202005128941C

Dear Eva:

Florida State Clearinghouse staff has reviewed the proposal under the following authorities: Presidential Executive Order 12372; § 403.061(42), Florida Statutes; the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended; and the National Environmental Policy Act, 42 U.S.C. §§ 4321-4347, as amended.

The proposed project has been reviewed by the Department of Environmental Protection's Central District and it has determined that it may require a DEP Drinking Water Main Extension Permit, NPDES Stormwater Permit, a Dewatering permit, an Industrial Wastewater Permit and a possibly an Environmental Resource Permit (ERP): • The activities may require a Conceptual ERP Permit and/or an Individual ERP Permit pursuant to 373, F.S. for wetland impacts and stormwater control requirements. If required, the project will be reviewed under the Environmental Resource Permit Applicant's Handbook I and II (Chapter 62-330, F.A.C.). • If wetlands and other surface waters are proposed to be impacted by the project, a demonstration of the elimination and reduction of wetland and surface water impacts will be required and any unavoidable impacts will require mitigation pursuant to Chapter 10.3 A.H. Vol I. • Any portion of the project that crosses sovereign, submerged lands will require a public easement through the Department's Division of State Lands (Chapter 18-21.005, F.A.C.).

The Florida Department of State has reviewed the proposed action and submitted comments. As a courtesy, these have been attached to this letter and are incorporated hereto.

Based on the information submitted and minimal project impacts, the state has no objections to allocation of federal funds for the subject project and, therefore, the funding award is consistent with the Florida Coastal Management

Program (FCMP). The state's final concurrence of the project's consistency with the FCMP will be determined during any environmental permitting processes, in accordance with Section 373.428, Florida Statutes, if applicable.

Thank you for the opportunity to review the proposed plan. If you have any questions or need further assistance, please don't hesitate to contact me at (850) 717-9076.

Sincerely,

Chris Stahl

Chris Stahl, Coordinator
Florida State Clearinghouse
Florida Department of Environmental Protection
3800 Commonwealth Blvd., M.S. 47
Tallahassee, FL 32399-2400
ph. (850) 717-9076
State.Clearinghouse@floridadep.gov